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# ENVIRONMENTAL ASSESSMENT BOARD



## ONTARIO HYDRO DEMAND/SUPPLY PLAN HEARINGS

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**VOLUME:** 146

**DATE:** Wednesday, May 13, 1992

### **BEFORE:**

|                              |          |
|------------------------------|----------|
| HON. MR. JUSTICE E. SAUNDERS | Chairman |
| DR. G. CONNELL               | Member   |
| MS. G. PATTERSON             | Member   |

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ENVIRONMENTAL ASSESSMENT BOARD  
ONTARIO HYDRO DEMAND/SUPPLY PLAN HEARING

IN THE MATTER OF the Environmental Assessment Act,  
R.S.O. 1980, c. 140, as amended, and Regulations  
thereunder;

AND IN THE MATTER OF an undertaking by Ontario Hydro  
consisting of a program in respect of activities  
associated with meeting future electricity  
requirements in Ontario.

Held on the 5th Floor, 2200  
Yonge Street, Toronto, Ontario,  
Wednesday, the 13th day of May,  
1992, commencing at 10:00 a.m.

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VOLUME 146  
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B E F O R E :

THE HON. MR. JUSTICE E. SAUNDERS Chairman

DR. G. CONNELL Member

MS. G. PATTERSON Member

S T A F F :

MR. M. HARPUR Board Counsel

MR. R. NUNN Counsel/Manager,  
Information Systems

MS. C. MARTIN Administrative Coordinator

MS. G. MORRISON Executive Coordinator



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A P P E A R A N C E S

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(Cont'd)

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| F. MACKESY      | ON HER OWN BEHALF                              |
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| D. COLBORNE  |   | NIPIGON ABORIGINAL PEOPLES'<br>ALLIANCE         |
| R. CUYLER    |   | ON HIS OWN BEHALF                               |
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| L. CHAN      | ) |   |



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1           ---Upon commencing at 10:02 a.m.

2           THE REGISTRAR: Please come to order.

3           This hearing is now in session. Please be seated.

4           THE CHAIRMAN: Mr. Fedorsen?

5           MR. FEDORSEN: Thank you.

6           DAVID WHILLANS,  
7           KURT JOHANSEN,  
8           FRANK CALVIN KING,  
9           WILLIAM JOHN PENN,  
10          IAN NICHOL DALY; Resumed.

11          CROSS-EXAMINATION BY MR. FEDORSEN (Cont'd):

12          Q. Mr. Johansen, yesterday there was an  
13          undertaking given with respect to past studies on peak  
14          values that Hydro may have done in terms of emissions,  
15          particularly of hydrogen sulphide. Did you get a  
16          chance at all over the evening to find anything out  
17          about that for us?

18          MR. JOHANSEN: A. No.

19          Q. Fair enough.

20          You had indicated yesterday, Mr.  
21          Johansen, that you agreed with the proposition that  
22          immature organisms are particularly susceptible to the  
23          adverse effects of most toxins, you said that it  
24          sounded reasonable and you wouldn't dispute.

25          We move that into something slightly more  
particular. Would you be confident, having agreed to  
that statement, would you be confident that let's say

1       an exposure of 1 to 4 parts per million of hydrogen  
2       sulphide gas wouldn't have any adverse health effects  
3       on a developing embryo? Let's say if you had that  
4       exposure for 1 to 2 seconds, would you be confident in  
5       saying no problem?

6                     A. I couldn't make that assessment. I  
7       wouldn't attempt to make that assessment. I would have  
8       to rely, as I said yesterday, on the assessment of  
9       people who are competent to make that sort of  
10      assessment, and/or the regulators who set the standards  
11      intended protect humans and the environment.

12                  Q. But apart from your reliance, sir, on  
13      the regulators, I think you yesterday indicated --

14                  THE CHAIRMAN: He said this many, many  
15      times, Mr. Fedorsen. He doesn't have anything more to  
16      offer on this particular point.

17                  MR. FEDORSEN: I know that.

18                  THE CHAIRMAN: So I wish you would go on  
19      to something else.

20                  MR. FEDORSEN: I'm sorry, I didn't ask  
21      the question I was going to ask. I was going to ask  
22      whether or not he felt that he should be scrutinizing  
23      the regulatory standards.

24                  THE CHAIRMAN: He talked about that  
25      yesterday. You asked him about it and he said yes he

1       though Hydro should provide a leadership role, but he  
2 personally can't help you any more on this point.

3                    MR. FEDORSEN: I understand that. I  
4 understand. But we are going to be getting into the  
5 some of the things that Hydro have been saying  
6 throughout the course, I guess, of a number of years to  
7 find out if their position with respect to concerns for  
8 health is matching what this panel of experts is  
9 telling us we should be concerned with. And that's  
10 where I am going to.

11                  THE CHAIRMAN: All right. You tilled  
12 this ground pretty thoroughly and I don't think it is  
13 of much more help to the panel.

14                  MR. FEDORSEN: If you bear with me a  
15 little bit, I will mind your admonishments if I keep it  
16 up and run afoul, but just bear with me a little bit  
17 longer and see if I can get to where I want to go,  
18 please.

19                  Q. If we take your position that you  
20 have just cited on the one to four parts per million  
21 for one to two seconds, common sense would indicate  
22 that if those exposures occur, let's say, 10 days in a  
23 row, your position would be even more cautious than it  
24 would be now; in other words, the more exposures we  
25 get, the more you are going to proceed with more

1 caution, correct?

2 MR. B. CAMPBELL: Just a minute. We have  
3 got about six questions here.

4 There has been no position taken on one  
5 to four parts per million. If the question is the  
6 question that was at the end that have speech, that is  
7 as a general rule the more exposure, the more caution,  
8 I am content to leave that question. But there has  
9 been no position taken as described in that question.  
10 And I think the witness is entitled, Mr. Chairman, to  
11 know which of these several questions he is being asked  
12 to answer.

13 MR. FEDORSEN: Let's go on. I'm going to  
14 try and work off this hour and a half time limit.

15 Q. The point is obvious, Mr. Johansen,  
16 the more exposures, the more potential difficulty;  
17 correct?

18 MR. JOHANSEN: A. I have acknowledged  
19 that.

20 Q. Yes, you have.

21 If you look, sir, at tab 10 of the  
22 materials, which is a letter that was written in this  
23 case to Bourgeois.

24 A. Yes, I have that.

25 Q. Thank you. I am interested in, first

1 of all, we get this second paragraph that talks about  
2 the measurements being very low and we went through  
3 this all yesterday about on the face of it, if you are  
4 not a mathematician you might misread the idea of 20  
5 parts per million not understanding what peak values  
6 could be, but forget about that. The next paragraph,  
7 and we are not trying to get at blame on people, I just  
8 wonder if this is accurate. It says: As stated on  
9 numerous occasions... and we will skip down.  
10 Basically the emissions haven't caused - and I  
11 underline the word - any health effects for you and you  
12 are family.

13 You, with your expertise, have backed off  
14 from becoming definitive on this issue of momentary  
15 exposures of relatively high levels, one to four parts  
16 per million, is this, given your expertise, sir, an  
17 accurate letter?

18 MR. B. CAMPBELL: Mr. Chairman, this  
19 witness has said he does not have expertise on this  
20 matter. What he has said is he is unable to express an  
21 expert opinion on this type of question. He said it  
22 about 16 times. I wish my friend would listen to the  
23 answers.

24 MR. FEDORSEN: Let me put it this way --  
25 MR. B. CAMPBELL: He does not have

1 expertise to deal with that. He has said so.

2 He has not said anything like my friend  
3 has said. What he said is, I don't know personally  
4 because I don't have expertise in the area.

5 MR. FEDORSEN: Q. Let me put it this  
6 way: Does White have the expertise to say that?

7 THE CHAIRMAN: I don't think it matters.  
8 You don't have to answer that question.

9 MR. FEDORSEN: With respect, Mr.  
10 Chairman --

11 THE CHAIRMAN: It doesn't matter, Mr.  
12 Fedorsen, to this Panel.

13 MR. FEDORSEN: Well, somebody is being  
14 told there is no health effects.

15 THE CHAIRMAN: This Panel is interested  
16 in the effects of hydrogen sulphide and its affect in  
17 the environment. We are very interested in that. We  
18 are not interested in whether Mr. White is an expert or  
19 is not an expert, or what he said on whatever date the  
20 letter is, I can't even see the date. It looks like  
21 sometime in 1990.

22 MS. PATTERSON: So why don't you ask for  
23 an undertaking to ask this question because obviously  
24 this panel is not going to answer it. If you want an  
25 answer, ask for an undertaking; if you want to just

1 bring your own evidence, do that.

2 MR. FEDORSEN: I will do that, thank you  
3 very much, Ma'am.

4 Q. I keep running into this roadblock,  
5 Mr. Johansen, of what you feel you can answer and what  
6 you feel can't answer.

7 THE CHAIRMAN: I think he has made it  
8 abundantly clear what he can answer and what he can't  
9 answer. We spent and hour yesterday going, speaking  
10 for myself alone, basically wasting time because he  
11 have gave the answer very early and there is no way you  
12 are going to get him to change it.

13 MR. FEDORSEN: The position that you took  
14 yesterday, and I must say, Mr. Chairman, I reread or I  
15 read, actually a couple of times, the transcript of  
16 yesterday's proceeding. Mr. Chairman, I think you had  
17 indicated that Hydro doesn't agree with the one to four  
18 parts per million theoretical that was put to Mr.  
19 Johansen. I think Mr. Johansen's evidence more  
20 accurately stated yesterday would have been that he  
21 wasn't in a position to agree or disagree. I can show  
22 you the transcript reference.

23 THE CHAIRMAN: I think that's right. I  
24 don't quarrel with that.

25 MR. FEDORSEN: Yes.

1                   THE CHAIRMAN: I don't quarrel with that.

2                   MR. FEDORSEN: I understand that, sir.

3                   Q. ... If you look, sir, Mr. Johansen, at  
4 tab 59, please.

5                   MR. JOHANSEN: A. Yes.

6                   Q. This would have been a report, I  
7 think it was prepared, is it, by Mr. Edwards, who is an  
8 atmospheric physicist, reviewed by Mr. Melo, and as I  
9 look at this, this report looked like it was  
10 distributed to you. Did you get a copy of this?

11                  A. I did not.

12                  Q. You didn't?

13                  A. Where is the indication that it was  
14 distributed to me?

15                  Q. Back page, sir, right at the very  
16 back page of the exhibit, it says distribution.

17                  A. Oh, well, I see that, but for some  
18 reason it hasn't reached me. I have been at these  
19 hearings and I have been back at my office from time to  
20 time checking my mail, and I can honestly tell you that  
21 I have not received a copy of this. And in fact, as we  
22 only received these materials on our way home the night  
23 before you are beginning cross-examination, I in fact  
24 still have not had an opportunity to carefully review  
25 this document.

1                   I may have a copy there when I get there  
2       next, but this is not a document that I had seen  
3       previously.

4                   Q. It goes to you for review though, in  
5       your capacity of Hydro?

6                   A. No one discussed this with me. I can  
7       only assume that because I have some responsibility for  
8       environmental assessment, that someone -- I happen to  
9       know these people at research division, I suppose they  
10      assumed that I would have some interest in it, but I  
11      had no role in the review of Professor Lumley's letter.

12     [10:11 a.m.]

13                  So the fact that they have seen fit to  
14      distribute a copy to me is quite normal, I would say.

15                  THE CHAIRMAN: Just a moment, please. I  
16      am a little confused. My tab begins with three charts,  
17      pages of charts. And then it starts on page 2 of the  
18      document.

19                  Page 1 does seem to be missing. And it  
20      goes through to page 40, although it looks like it goes  
21      through to page 40. And then there's a document  
22      described as last page at the end which isn't numbered.

23                  MR. FEDORSEN: Yes. It's on that last  
24      page, Mr. Chairman.

25                  THE CHAIRMAN: But is there a page 1, am

1 I missing a page 1?

2 MR. FEDORSEN: If there is a page 1, we  
3 weren't given it. If there is one, I guess --

4 MR. B. CAMPBELL: There is a page 1 that  
5 looks like this. It has Ontario Hydro's Research  
6 Division on the front.

7 THE CHAIRMAN: We don't have that.

8 MR. JOHANSEN: I was also missing the  
9 front page, Mr. Chairman.

10 MR. B. CAMPBELL: It didn't come with a  
11 copy. The report, as I understand it, has just  
12 recently been issued. As I say, I managed to obtain a  
13 front page. Of course, I haven't discussed --

14 THE CHAIRMAN: Page 40 is the second-last  
15 page and the last page is the last page, is that  
16 correct?

17 MR. B. CAMPBELL: It's a good rule of  
18 thumb. I understand that that is correct, the page  
19 with the distribution is the last page and there is  
20 nothing between 40 and the last page. We understand  
21 that to be the case. If you like, I can go make some  
22 copies of the first page.

23 THE CHAIRMAN: No, no. I just wanted to  
24 make sure there wasn't any confusion.

25 MR. FEDORSEN: I will say, Mr. Chairman,

1       there is a whole host of references in this that we  
2       didn't reproduce, just the references to the article,  
3       and that was simply to save some money. I didn't think  
4       it was necessary.

5                    MR. B. CAMPBELL: We will supply copies  
6       to everyone of the first page. And if they could be  
7       inserted in the exhibit, I think it would be sensible  
8       to have the first page.

9                    MR. FEDORSEN: Q. When it goes to you,  
10       Mr. Johansen, for distribution, are you expected to  
11       give an opinion, or is this just for, I guess, your  
12       records?

13                  MR. JOHANSEN: A. Just for information,  
14       I assume. There's no, well, unless the front page  
15       indicates some request for comments. I would not  
16       consider this to be anything other than a copy for  
17       information. I get copies of all kinds of reports  
18       prepared by the Research Division within the general  
19       field of environmental analysis, behaviour of  
20       contaminants in the environment, things of that sort.  
21       I guess you could say I'm on their standard  
22       distribution list, and that's all that means.

23                  Q. I guess I'm wasting my time to get a  
24       response as to whether you agree with the line on page  
25       5, second paragraph, above that 4.0 magnitude of peaks

1       due to response characteristic of the instrument  
2       attenuations on the order of what Professor Lumley  
3       suggested theoretically possible. You can't help us  
4       whether you agree with that position that was taken by  
5       the Hydro Consultant, or not? You can't go that far  
6       for me today?

7                     A. As I said, I haven't had an  
8       opportunity to review this. And it would be a document  
9       that would require careful and considerable review. So  
10      I really can't comment.

11                  Q. I accept that, Mr. Johansen. I  
12      accept that. I want to deal with the '85 gas  
13      emissions. And if you turn, please, sir, to -- well,  
14      maybe before we turn there, maybe there's something  
15      here you can agree with.

16                  On page five of that last tab, you'll see  
17      that this scientist in 4.0 magnitude of peaks, towards  
18      the end of that paragraph, he's talking about  
19      efficiency of the flaring-off process. Are you with  
20      me, sir?

21                  A. Yes.

22                  Q. He says a worst case combustion  
23      efficiency is considered to be 90 per cent. First of  
24      all, if I can do it in sequence, Hydro is interested  
25      basically, I understand, in worst case scenarios,

1       that's what you are planning for, the worst possible  
2       situations?

3                     A. Well, in the sense that we do take  
4       abnormal or sometimes worst case scenarios into  
5       account, in fact, we are often required by legislation  
6       regulations to do so and have specific environmental  
7       models for worst case scenarios. Yes, that's not  
8       unusual.

9                     Q. You have a little bit more expertise,  
10      maybe, on the issue of design, I guess, of plants than  
11      most people in this province would have. Are you going  
12      to disagree with the proposition that if we take, let's  
13      say, 50 tonnes of hydrogen sulphide and burn it off at  
14      the Bruce heavy water plant that you could have five  
15      tonnes of that going out into the environment; do you  
16      disagree with that assumption?

17                    A. Well, those numbers are hypothetical,  
18      but I can agree with what seems to be your underlying  
19      suggestion, which is that we can't always guarantee 100  
20      per cent combustion at the flare stack despite attempts  
21      to ensure that there is optimal combustion conditions  
22      and including the supply of propane.

23                    Q. There could be situations where  
24      there's 10 per cent of the total burn off emitted into  
25      the air in terms of hydrogen sulphide gas, can we agree

1       on that?

2                     A. I agree that is an assumption that  
3       has been made conservatively for worst case analysis  
4       purposes.

5                     Q. And that assumption was made by  
6       someone actually employed by Hydro?

7                     A. Yes.

8                     Q. Okay.

9                     DR. CONNELL: Mr. Johansen, are the units  
10      here grams per second in this passage?

11                    MR. JOHANSEN: Yes, a little further up.  
12      Yes, Dr. Connell, that's my interpretation.

13                    MR. FEDORSEN: Q. All right. So I don't  
14      want to do this ad nauseum, but let's just take a  
15      couple of examples of gas emissions. Let's deal with  
16      '85. If you look at tab 29, please, sir. If you go,  
17      these aren't numbered, but if you go in five pages to  
18      May 8th of '85.

19                    THE CHAIRMAN: Is this Interrogatory  
20      9.21.106?

21                    THE REGISTRAR: That's .170, Mr.  
22      Chairman.

23      ---EXHIBIT NO. 520.170: Interrogatory No. 9.21.106.

24                    MR. FEDORSEN: I'm sorry, your Honor.

25                    THE CHAIRMAN: I'm sorry, what page did

1       you say?

2                    MR. FEDORSEN: I'm sorry. I'm not  
3       numbering these like this board is. I'm didn't  
4       realize. I'll try to reference the interrogatory  
5       number. I was doing it off my numbers. but this looks  
6       to me like 9.21.106 and it's the fifth page in, 1985  
7       complaint.

8                   Q. Are you with me, Mr. Johansen, 08/85?

9                   MR. JOHANSEN: A. Yes, I am.

10                  Q. Talking about reports of odour. They  
11       say here, this is a separate problem that survey crews  
12       were off-site because of a labour dispute. They say  
13       that there were no off-site monitors registering any  
14       detectable sulphide or sulphur dioxide concentrations.  
15       It appears, and I'm not trying to make any point on  
16       this but I'm just trying to get accurate here, that  
17       when we looked up the letter to the Honourable Vincent  
18       Kerrio, he is referenced with respect to a gas leak, a  
19       reading of 25 parts per billion.

20                  I'm going to say to you, there might have  
21       been some monitor somewhere registering 25. But that's  
22       not what I want you to consider. There's your  
23       complaint in that interrogatory. Now, if you go to --

24                  A. Yes.

25                  Q. With me?

1                   A. And this would be referring to the  
2 permanent monitoring system and the readings from those  
3 seven Ontario Hydro environmental monitors and the  
4 permanent Ministry of the Environment monitor.

5                   Q. Do you have knowledge of whether or  
6 not there was a reading of 25 parts per billion on  
7 another monitor not mentioned here?

8                   A. Not in this context. This is  
9 consistent with what I know.

10                  Q. All right. If you turn to tab 27,  
11 which would be Interrogatory 9.21.102.

12 [10:25 a.m.]

13                  THE REGISTRAR: Which is .171.

14 ----EXHIBIT NO. 520.171: Interrogatory No. 9.21.102.

15                  MR. FEDORSEN: Q. This gives us a  
16 graphic overview of hydrogen sulphide releases to the  
17 flare, I guess from '85 to '90. Am I describing this  
18 right?

19                  MR. JOHANSEN: A. Yes. Interrogatory  
20 9.21.102 which you have referred to presents annual  
21 total emissions from '85 to '90, and monthly breakdowns  
22 for each of those years, and at the back, some  
23 explanation of the nature of the activities associated  
24 with those emissions, whether they were the result of  
25 purchasing of equipment, perhaps for maintenance

1       purposes, chronic emissions, leaks, things of that  
2       sort, or scheduled outages.

3                   Q. Okay. As I said to you yesterday, I  
4       am not concerned for my purposes with leaks. That's  
5       something that can happen and I am sure you people  
6       track those things like of down line crazy if they do  
7       occur. I am concerned with the controlled emissions.

8                   If you look at the graph indicating the  
9       releases in 1985, first of all, if you will bear with  
10      me, these readings, I want to convert them into tons.  
11      If I look around, you see the '85 graph, 250?

12                  A. Yes.

13                  Q. If we get to 250, that would be at  
14       least 250 tons, am I right, when we convert that from  
15       metric back to ton?

16                  A. The units applicable to the chart as  
17       a whole are megagrams or metric tonnes.

18                  Q. Okay. In the May of '85 what have we  
19       got there released? About 240, I will call them  
20       tonnes, for my purposes? Does that seem right?

21                  A. Something like that.

22                  Q. Something like that. Approximately.

23                  A. Yes. Well, Dr. Whillans just made a  
24       point here, that the way to interpret this chart is  
25       that these were H(2)S releases to the flare stack.

1 Q. Yes, I understand that.

2 A. They are not intended to be  
3 —representative of emissions to the environment.

4 Q. Yes, I understand that.

5 A. And I believe somewhere there is an  
6 explanation that these quantities are based on  
7 inventory comparisons and it's conservatively assumed,  
8 reasonably assumed that the differences or the losses  
9 in inventory are all released to the flare stack. So  
10 that is the context.

11 Q. Yes, I understand. The bottom line  
12 is, in May of '85, approximately 240 tonnes are sent up  
13 to be burnt off, the reference is hydrogen sulphide;  
14 correct?

15 A. That's what the chart shows, yes.

16 Q. And in April, I am just going to  
17 ballpark this, it looks like around — what would that  
18 be, 175 tonnes?

19 A. Approximately.

20 Q. Okay. So 240 and 175, let's round  
21 that off at around 400 tonnes; is that fair, April and  
22 May?

23 A. Approximately.

24 Q. Okay. And on the worst case scenario  
25 that you told us that you couldn't necessarily disagree

1 with, am I right in saying that in May and April of '85  
2 you could have had a release of 40 tonnes of hydrogen  
3 sulphide into the environment after the flaring-off  
4 process; is that fair?

5 A. No, I couldn't agree with that.

6 Q. Why not?

7 A. When we are talking about a worst  
8 case scenario, we are talking about a situation that  
9 would occur for a very short period of time.

10 Q. I'm sorry?

11 A. We are assuming a situation that  
12 would occur for a very short period of time.

13 I certainly couldn't agree to apply a  
14 worst case scenario to a monthly or even two-monthly  
15 total. That is not what the worst case scenario is  
16 intended to be applied to.

17 Q. Was this burn-off in April or May  
18 done in an unusual sense insofar as the normal  
19 employees who would do it weren't doing it, management  
20 was doing this burn-off?

21 A. I am just looking at the table, the  
22 figures at the back. There is no explanation other  
23 than in the footnote that goes with that table, if you  
24 know what I am talking about.

25 Q. Yes, sir, I do.

1                   A. The first footnote pertaining to the  
2 outage release in May of 1985, which indicates, and I  
3 believe that was documented elsewhere in one of the  
4 documents in your materials, it indicates that on the  
5 2nd of May of that year, the enriching units of E3 and  
6 E4 of Plant B were ordered shut down because of the  
7 impending walk-out by the OHAU, the employees' union.

8                   Q. Do they normally do the burn-off?

9                   A. They.

10                  Q. Do they normally work in the burn-off  
11 phase? Do they actually turn the levers and do  
12 whatever you have to do to burn off this gas?

13                  A. I'm wondering who it is you are  
14 referring to when you say "they"?

15                  Q. Members of the union.

16                  THE CHAIRMAN: I am really wondering what  
17 this has to do with our problem, our concerns. There  
18 was an episode apparently in May, April or May of 1985  
19 that may have caused an unusual amount of emission, but  
20 I'm not sure how that helps us except to note that  
21 these things may occur and that this may happen.

22                  MR. FEDORSEN: I agree with you. I am  
23 not here to say anything about who did the burn-off. I  
24 am interested in Mr. Johansen's evidence on the worst  
25 case scenario. Let me get back on track with that.

1                   Q. You say that -- when I put the  
2 hypothetical to you that it looks like if 10 per cent  
3 is not burned off 40 tonnes could go into the  
4 atmosphere, you say no, no, that's not right because it  
5 isn't a 90 per cent burn-off, it's something much  
6 higher in effect. That's really what you are telling  
7 us; aren't you?

8                   MR. JOHANSEN: A. On a longer term  
9 average basis I would expect it to be considerably  
10 higher than the 90 per cent assumed in the short-term  
11 worst case scenario, yes.

12                  Q. In April and May was the bulk of  
13 this -- in '85, and we can go through each year, I am  
14 not going to, but was the bulk of these emissions  
15 occurring over let's say, what, a 10-day period, a 20-  
16 period? In other words it's not really 60 days, April  
17 and May, it's really going out in a much shorter time,  
18 isn't it, Mr. Johansen?

19                  A. Well, the only detailed information  
20 that I can offer is what is presented along with these  
21 charts--

22                  Q. Yes, sir.

23                  A. --under 9.21.102, and it breaks it  
24 down by month only as to the nature of the activity and  
25 doesn't provide a daily a breakdown.

1                   So I really can't say. It's my general  
2 understanding, however, that during this period  
3 following -- that the release associated with the  
4 shutdown was conducted in a normal manner, and that  
5 following the shutdown, management operated the system  
6 according to standard procedures, simply to maintain  
7 the plant in a safe condition.

8                   Q. We are not disputing that. All I am  
9 after is, is there some way to find out whether or not  
10 these emissions which are graphed from April to May, a  
11 period of about 60 days, are in fact occurring really  
12 over about 10 days? Is there some way we can find that  
13 out or there are no records for that?

14                  A. I don't have that information. It's  
15 obviously not presented here, so that's as far as I can  
16 go, right here.

17                  Q. I could be right, I could be wrong,  
18 but maybe these emissions are occurring over 10 days,  
19 no way to tell.

20                  A. I can't say one way or the other.

21                  Q. I have looked at something that you  
22 said back - and I am not going to quote this - I will  
23 give it to my friend so I don't get into a long  
24 diatribe here. Just basically that you were concerned  
25 at one stage in your evidence with respect to

1 instantaneous concentrations in terms of chemical  
2 releases. You are on record saying that. That's  
3 because you as a scientist know that peak values can be  
4 very important in studying health effects. Am I right  
5 on that, sir?

6 MR. B. CAMPBELL: Could we hold it for a  
7 minute, please.

8 MR. JOHANSEN: Well, I think I responded  
9 in the context, which was a discussion including not  
10 only absolute values, peaks or average, but time of  
11 exposure as well. So certainly all I said was that  
12 exposure or dose is, in any situation, to be taken as  
13 some combination of concentration and time of exposure.

14 MR. FEDORSEN: Okay.

15 DR. CONNELL: Mr. Johansen, just to probe  
16 this matter of the rate. If I go back to tab 59, on  
17 page 5.

18 MR. JOHANSEN: I'm sorry, Dr. Connell, I  
19 was distracted for a moment.

20 DR. CONNELL: Under tab 59, on page 5, it  
21 suggests under Plume Rise and Spread, the second  
22 sentence, a mixture of water vapour, H(2)S and it gives  
23 the rate of 680 grams per second as you acknowledged  
24 earlier. I take that to be the standard rate during  
25 the flare. That's subject to confirmation, but if that

1       is correct, 680 grams per second works out to about  
2       two-and-a-half metric tonnes per hour - this is subject  
3       your to confirm of confirmation - which would be of the  
4       order of 60 metric tonnes per day.

5                     So even if the flare were operating  
6       around the clock, 24 hours a day, on consecutive days,  
7       it would take, say, four days of such continuous  
8       operation to achieve the rate of H(2)S release given in  
9       May of '85, and it would take another three days of  
10      continuous around-the-clock operation for the April  
11      emissions.

12                   So that gives at least boundary  
13      conditions for Mr. Fedorsen's questions, would you  
14      agree?

15                   MR. JOHANSEN: Yes, that sounds  
16      reasonable to me. I have no problem with that kind of  
17      range.

18                   MR. FEDORSEN: Q. My information, and I  
19      stand to be corrected --

20                   MR. JOHANSEN: A. Perhaps I could just  
21      add. Again, there is lot of material here, but I do  
22      recall in scanning through this material that there was  
23      acknowledgement from Ontario Hydro of a certain range  
24      of H(2)S emissions in terms of metric tonnes per unit  
25      time. And if you look at that, you might gain further

1       insight into the time period over which these emissions  
2       were released. I just can't pin point exactly where  
3       that would have been.

4                   Q. I appreciate that. We have been  
5       scrutinizing this to try to find out how quickly this  
6       is set out.

7                   All I want to establish, and again don't  
8       think I am trying to be critical, maybe we will make a  
9       recommendation in the future you should keep better  
10      records of exactly what goes out and so on, but the  
11      past is the past.

12                  MR. B. CAMPBELL: Just a minute.

13                  Mr. Chairman, my friend can make whatever  
14      recommendation he wants at the time of argument, but  
15      now is the not the time to do it. But quite frankly,  
16      he hasn't asked what records we kept over that period.  
17      He has asked whether Mr. Johansen has any knowledge of  
18      what is done on a day-by-day basis and he said, no, I  
19      don't.

20                  MR. FEDORSEN: Q. Let me ask you. Do we  
21      have records, so that we can tell in accordance with  
22      Dr. Connell's position and the parameters, so we can  
23      find out how many days we are talking about with all  
24      this potential hydrogen sulphide emissions? Do you  
25      have records?

1 [10:37 a.m.]

2 MR. JOHANSEN: A. I can't say exactly.

3 THE CHAIRMAN: Well, perhaps if there are  
4 such records they can be produced.

5 MR. B. CAMPBELL: Sure. We can make  
6 inquiries if my friend would like to see whether we  
7 have a daily pattern for April to May. We'd be glad to  
8 provide it.

9 THE CHAIRMAN: An undertaking number for  
10 that?

11 THE REGISTRAR: 532.19.

12 ---UNDERTAKING NO. 532.19: Ontario Hydro undertakes to  
13 provide, if available, records as to the  
14 time periods over which emissions are  
15 released for April and May of 1985.

16 THE CHAIRMAN: That's for April and May,  
17 I'm sorry, of 1985?

18 MR. FEDORSEN: Actually, if I can get  
19 them, if they've got these records, I would like them  
20 from '85 current. If they've got them. It would be  
most helpful to us.

21 THE CHAIRMAN: That would be pretty  
22 massive. Is that what you say, Mr. Campbell?

23 MR. B. CAMPBELL: There's been a focus on  
24 a particular time of a high period. I'm quite prepared  
25 to do that. But I'm not prepared be as bold as to ask

1 for what is now seven years of operating records to be  
2 appropriate. I think that's inappropriate.

3 THE CHAIRMAN: Let's start with April and  
4 May.

5 MR. FEDORSEN: If I can come back to the  
6 board. If we get April and May, I'll come back and  
7 make submissions at some point if it's going to get  
8 anybody anywhere, and I'll leave it at that if I can  
9 and move on.

10 THE CHAIRMAN: Fine.

11 MR. FEDORSEN: Thank you.

12 Q. Now, after that particular release  
13 that I referenced the tab number to, you are now aware  
14 that at least one human being had complained of  
15 symptoms of being nauseous, headaches, staggering  
16 around, he felt drunk; he had the taste of hydrogen  
17 sulphide in his mouth, and he had to lay down for about  
18 an hour. That was in 1985. And you are aware of those  
19 symptoms because Hydro has been studying this problem,  
20 is that right?

21 THE CHAIRMAN: Are you asking him if you  
22 was aware of this individual case? Is that what you  
23 are asking?

24 MR. FEDORSEN: Q. Yes, these symptoms  
25 after this exposure.

1                   MR. JOHANSEN: A. Well, I'm aware that  
2 there were complaints.

3                   THE CHAIRMAN: He's asking if you are  
4 aware of this particular person who apparently in April  
5 or May of 1985--is that correct?

6                   MR. FEDORSEN: Yes, sir.

7                   THE CHAIRMAN: --experienced the symptoms  
8 that he has described.

9                   MR. JOHANSEN: Well, I have to say I'm  
10 not sure just what exactly you are referring or who you  
11 are referring to here. You are representing Mr.  
12 Bourgeois, obviously. I would assume that was your  
13 reference.

14                  THE CHAIRMAN: I don't think you should  
15 assume anything of that nature.

16                  MR. JOHANSEN: What I know is --

17                  THE CHAIRMAN: Do you know the individual  
18 he's referring to?

19                  MR. JOHANSEN: Well, I would have to ask  
20 the question, what individual are you referring to?

21                  THE CHAIRMAN: The obvious answer is no,  
22 I take it.

23                  MR. JOHANSEN: I need to have it defined.

24                  MR. FEDORSEN: We can make this really  
25 simple.

1                   MR. JOHANSEN: I'm sorry.

2                   MR. FEDORSEN: Q. I would have liked to  
3                  have taken you through --

4                   THE CHAIRMAN: No, no, please. Either  
5                  abandon this particular line or do something else. But  
6                  let's not leave it hanging like this. Are you asking  
7                  about a individual? And if so, I think you should tell  
8                  him who it is.

9                   MR. FEDORSEN: Q. Yes. I wondered if he  
10                 was aware of symptoms Bourgeois, apart from his flock,  
11                 had passed along to Hydro from '85 to current?

12                 THE CHAIRMAN: You are talking about Mr.  
13                 Bourgeois himself?

14                 MR. FEDORSEN: Yes, sir, specifically.

15                 MR. JOHANSEN: All right. My familiarity  
16                 with that particular case extends only to what is  
17                 documented in the materials.

18                 MR. FEDORSEN: Q. Okay.

19                 MR. JOHANSEN: A. I have never been  
20                 involved in a review of the situation back to '85.

21                 Q. Okay. So basically what you know is  
22                 from reviewing the materials?

23                 A. Yes.

24                 Q. You wouldn't rule out, from having  
25                 read the materials, that the line of symptoms - we are

1 talking about a human being now and we will move to the  
2 sheep in a minute - that those symptoms could be  
3 consistent with effects of hydrogen sulphide. You  
4 wouldn't rule that out.

5 MR. B. CAMPBELL: Mr. Chairman --

6 THE CHAIRMAN: He's not a medical doctor.

7 I don't know why he should be asked that question.

8 MR. B. CAMPBELL: That's right, Mr.  
9 Chairman. And I think at the point where we are so far  
10 beyond expertise here and given the claims that are  
11 being asserted by Mr. Bourgeois, I think it would be  
12 highly prejudicial to Ontario Hydro to require them to  
13 answer questions in this area in which he is clearly  
14 not expert.

15 MR. FEDORSEN: It's just this, Mr.  
16 Chairman and the Board. We can show you  
17 interrogatories where Hydro --

18 THE CHAIRMAN: We have the  
19 interrogatories with the table of symptoms. People who  
20 experience those symptoms may or may not, it may or may  
21 not be caused by the presence of hydrogen sulphide. I  
22 don't think Mr. Johansen can help you further on that.

23 MR. FEDORSEN: I guess I'm having a  
24 structural problem here. We have got interrogatories  
25 where Hydro consistently says nothing that's happening

1       on the Bourgeois property, be it lambs or whatever, are  
2       caused by anything, anything that Hydro is doing. I  
3       guess I'm stuck at this stage of none of these  
4       people -- somebody in Hydro must have come to that  
5       conclusion, and no one here seems to have the expertise  
6       to back that conclusion up. Is that the position we  
7       are left with?

8                            MR. B. CAMPBELL: In the end of Mr.  
9       Bourgeois' individual case, I think that is exactly  
10      correct; there is no one here with expertise in those  
11      particular matters. There's been extensive  
12      correspondence, review, reports, regulatory  
13      investigation, all in connection with this matter over  
14      many, many years. That's a completely different  
15      matter, but we do not have particular expertise on that  
16      situation here, that's right.

17                          THE CHAIRMAN: Hydro has given evidence  
18      that certain emissions of hydrogen sulphide create  
19      certain symptoms in human beings. Whether a particular  
20      human being who experiences those symptoms is due to  
21      hydrogen sulphide is an individual question of fact and  
22      I don't think it's anything that we need to get into in  
23      this particular --

24                          MR. FEDORSEN: I guess my difficulty is  
25      they give the evidence on one hand of what is going to

1 happen at certain levels, and then when we ask them  
2 what happens at other levels, they say they are not  
3 qualified to answer it. That's the problem I'm having.

4 MS. PATTERSON: I guess it's up to us to  
5 assess the weight of the evidence, and you are  
6 certainly allowed to bring your own evidence. It might  
7 be more persuasive.

8 MR. FEDORSEN: Thank you very much. I  
9 appreciate that.

10 Q. Let's follow up from what your  
11 counsel just said, then, and this can save us a great  
12 deal of time, then, because hopefully somebody is going  
13 to be able to call Mr. Reiffenstein as a witness and  
14 maybe we can get to the bottom of some of this.

15 Your counsel just said there have been  
16 years of investigations into this Bourgeois matter.  
17 That's with respect to lambs being born without the  
18 ability to nurse, wandering around and the like,  
19 stumbling into things, incidents of blindness, and the  
20 like. What investigations have there been, sir, over  
21 the years as your counsel said, into this problem from  
22 Hydro?

23 MR. B. CAMPBELL: Mr. Chairman, my remark  
24 is simply recording the fact as it is recorded in these  
25 materials. Mr. Bourgeois has been pursuing this claim

1 for many, many years. There's been work done in  
2 response to Mr. Bourgeois' concerns by the Ministry of  
3 the Environment. There's been work done in response to  
4 Mr. Bourgeois' concerns with the Atomic Energy Control  
5 Board. There's been work done in response to Mr.  
6 Bourgeois' concerns by Ontario Hydro. And as I  
7 understand it, that material has been, the conclusions  
8 that have been reached have been communicated to Mr.  
9 Bourgeois.

10 Again, I do not see how this is useful to  
11 anything that the Board has to decide as to how Hydro  
12 has responded to the claims and allegations being put  
13 forward by Mr. Bourgeois. And I think when my client  
14 is in a position of being under threat of litigation  
15 from Mr. Bourgeois, unless it can be shown that these  
16 matters are directly relevant to the planning matters  
17 that are properly before this Board, my submission is  
18 it is highly detrimental to this client to permit them  
19 to be pursued and they should not be pursued.

20 MR. FEDORSEN: If I may reply. They are  
21 being pursued in the context of safety in a much larger  
22 scale. We are pursuing them in front of this board in  
23 the context of the accuracy of monitor readings, which  
24 is the cornerstone of many of the position Hydro has  
25 taken on many types of emissions. That is how we are

1                   pursuing this.

2                   This has nothing to do with anything  
3                   except the broad picture and Hydro's response, which  
4                   they have said over and over yesterday and on  
5                   transcript was one of not only being proactive, but was  
6                   one of wanting to engage in a debate emphasizing their  
7                   overall health concern of wanting to make sure  
8                   everything was done in a healthy manner. Counsel for  
9                   Hydro says, in effect, that Hydro has been  
10                  investigating these matters for years. I'm asking  
11                  Johansen what he can tell us about that.

12                  THE CHAIRMAN: Mr. Campbell has just  
13                  detailed to you what has been done, most of which, if  
14                  not all, you are aware of. And I don't know what more  
15                  Mr. Johansen can add to that.

16                  MR. FEDORSEN: The bottom line is there  
17                  haven't been investigations over the years apart from  
18                  saying the monitors are reading X, and I want to get  
19                  that from Mr. Johansen.

20                  THE CHAIRMAN: I'm a little frustrated.  
21                  I'm looking here at 59 tabs, all of which indicate that  
22                  both you and Ontario Hydro and other agencies have been  
23                  looking into this problem. I'm not sure what more you  
24                  want Mr. Johansen to say in addition to that.

25                  MR. FEDORSEN: I can tell you what I

1 think is the case and see if he'll say it. And if he  
2 doesn't --

3 THE CHAIRMAN: Well, then, suggest to him  
4 what is the case and see what he says.

5 MR. FEDORSEN: Let me put this directly.

6 Q. After you received the complaints  
7 from Bourgeois, up until 1991, let's call it January,  
8 apart from Hydro looking at monitor readings and taking  
9 the position that all was well because the monitors, as  
10 they were read, appeared to be within Ministry  
11 guidelines, what steps did Hydro take to investigate  
12 these assertions by Bourgeois, sir?

13 MR. JOHANSEN: A. In each case of an  
14 odour complaint, there is routinely carried out --

15 THE CHAIRMAN: No, no, please. Answer  
16 the question that you have been asked. What steps did  
17 you take with respect to this particular matter? Don't  
18 give a general answer.

19 MR. JOHANSEN: All right, Mr. Chairman,  
20 I'm sorry.

21 THE CHAIRMAN: You can expand on that  
22 after, but I think Mr. Fedorsen is entitled to an  
23 answer to the question that he's asked you. And that  
24 is, what steps have you taken other than --

25 MR. JOHANSEN: Perhaps you could just

1 clarify for me again the exact question.

2 MR. FEDORSEN: Could it be read back?

3 Could we do that?

4 THE CHAIRMAN: I think you should reframe  
5 it.

6 MR. FEDORSEN: I'll do it again, then.

7 Q. Dealing with the period prior to  
8 January, 1991 --

9 MR. JOHANSEN: A. Yes.

10 Q. Dealing with complaints where Mr.  
11 Bourgeois is telling Hydro about symptoms, telling him  
12 about lambs being, mangled and the like, I'm not going  
13 to go through all that, you know about it. Through May  
14 of '85 to January of 1991, apart from looking at the  
15 monitors and looking at the reading, reading the  
16 monitor, what steps did Hydro take to investigate Mr.  
17 Bourgeois' concerns?

18 A. Well, I'll try to answer it a little  
19 more directly. The steps that were taken to  
20 investigate the complaints for Mr. Bourgeois are  
21 similar to steps that are taken with regards to other  
22 complaints, would have included, first of all, an  
23 investigation of what activities, in fact, at the plant  
24 might have given rise to emissions that might, in turn,  
25 have given rise to concentrations in the vicinity of

1       Mr. Bourgeois' farm.

2                     And some investigation of the  
3     functionality of the monitor in question, that would  
4     have been the standard procedure. As to details of  
5     meetings, correspondence between Mr. Bourgeois or his  
6     representatives and Ontario Hydro, I'm generally aware  
7     that there was this dialogue, but I'm not aware of the  
8     details as I wasn't involved in it. Some of it I have  
9     seen in your materials.

10                  Q. So, then --

11                  A. Perhaps what I could say now, there  
12     have been investigations over the years on a routine  
13     basis, beginning with the first year of operation of  
14     the plant, which have led to refinements in procedure  
15     and, indeed, equipment at the plant to improve control  
16     of emissions.

17                  [10:50 a.m.]

18                  Q. Are you finished?

19                  A. Yes.

20                  Q. Thank you. If the Board is  
21     interested, we will maybe get a chance to hear from Mr.  
22     Bourgeois what was done.

23                  But let me put this to you. Apart from  
24     the undertaking that your counsel has given with  
25     respect to specific studies on these monitors, maybe

1       they were done, maybe they weren't, I don't know, we  
2       will see, can you tell me anything specific that was  
3       done regarding analyzing peak concentrations up until  
4       Bourgeois was able to, through the funding of this  
5       Board, get Lumley to tell you people that maybe there  
6       was a problem with peak concentrations, was there  
7       anything specific done until he got that report?

8                    MR. B. CAMPBELL: Mr. Chairman, we have  
9       taken an undertaking on this matter, and we have  
10      undertaken as part of that to say when did Hydro -- or  
11      did Hydro know that time average concentrations could  
12      have within the peaks, we have given that undertaking.  
13      I thought we went through all of this yesterday.

14                  I undertook to include that in the  
15      undertaking answer that we gave.

16                  THE CHAIRMAN: Do you disagree with that,  
17      Mr. Fedorsen?

18                  MR. FEDORSEN: No, I put it to the  
19      witness in the context of, apart from the undertaking  
20      was there something else.

21                  THE CHAIRMAN: The undertaking will  
22      answer the question for you. I don't think you need to  
23      ask it.

24                  MR. FEDORSEN: I am happy with that.

25                  THE CHAIRMAN: All right, go on to

1 something else.

2 MR. FEDORSEN: That is fine. As long as  
3 has my friend agrees that that is the sum total of what  
4 was done on the monitors.

5 THE CHAIRMAN: I think he said it very  
6 clearly.

7 MR. B. CAMPBELL: I had said we would  
8 find the matter out and we would report it in the  
9 undertaking.

10 MR. FEDORSEN: Perfect.

11 MR. B. CAMPBELL: I can't do any better  
12 than that and I said that yesterday, Mr. Chairman.

13 MR. FEDORSEN: That's just great. Thank  
14 you, very much.

15 THE CHAIRMAN: It would help, I would  
16 think, if you didn't editorialize quite so much in your  
17 questions, Mr. Fedorsen.

18 MR. FEDORSEN: Sometimes I get  
19 frustrated, that's all. I apologize.

20 Q. Dr. Whillans, I read something that  
21 you had said in your evidence a while ago actually, if  
22 you want to look at the volume, it's at 21200, but I  
23 can lead you to the point without reading it.

24 MR. JOHANSEN: A. Which volume.

25 Q. 21200, Volume 121, is what I have

1       got.

2                     DR. WHILLANS: A. I have it.

3                     Q. I am not going to quote it because it  
4       takes too long.

5                     Basically you were talking about in this  
6       case I think radiation, and you were talking about in  
7       the end that sometimes even studies on things like  
8       fruit flies can be helpful for scientists because I  
9       guess there is some sort of similarities even at some  
10      level between fruit flies and people. It's something  
11      that you wouldn't want to discard in terms of analysis  
12      in situations. Am I understanding your evidence right  
13      on that point?

14                   A. I think I agree with what you have  
15      said so far.

16                   Q. The idea is that anybody who is truly  
17      concerned with an open debate, which is what we talked  
18      about yesterday, would want to look and study closely  
19      any sorts of similarities when we chance accidents,  
20      let's say, of emissions, radioactive or hydrogen  
21      sulphide emissions, when you are seeing them effect  
22      animals other than humans. You want to look at that  
23      because it might teach you something as a scientist?

24                   A. Well, you said study closely, I think  
25      the closeness that you would study a particular

1        incident or a particular finding would depend on how  
2        relevant it appeared to be to a problem that was of  
3        concern.

4              Obviously there are situations which seem  
5        odd, which appear to be nothing to do with matters that  
6        are of concern and we don't study those closely. We try  
7        to set some sort of priority list.

8              Q. If you wouldn't mind, Doctor, if you  
9        could go to tab 13 for me. I am going to reference an  
10       article by Michael Prior, and that's from that 1989  
11       conference on hydrogen sulphide toxicity.

12             He talks, sir, at page 69, about the  
13       Lodgepole blowout. You are familiar with that somewhat  
14       I would take it?

15             A. I have no special knowledge of  
16       hydrogen sulphide problems at all.

17             Q. Okay. Let me direct then this  
18       question to Mr. Johansen.

19             The Lodgepole blowout was a situation  
20       where there was hydrogen sulphide in fairly high doses  
21       over a lengthy period of time, let's say nine weeks; is  
22       that a fair analysis?

23             MR. JOHANSEN: A. Well, I don't know  
24       those parameters, but I know there was a blowout at the  
25       Lodgepole well location, yes, that's about it.

1 Q. You don't know those parameters?

2 A. No. I know you have got material on  
3 it, but as I say, time just didn't permit a line by  
4 line review of all of that.

5 THE CHAIRMAN: Where is the reference to  
6 the period?

7 MR. FEDORSEN: Actually, you can... One  
8 second. I thought it was somewhere else. I will find  
9 it for you.

10 THE CHAIRMAN: Perhaps it may be that  
11 neither Dr. Whillans nor Mr. Johansen can help you very  
12 much in this.

13 MR. FEDORSEN: Maybe.

14 Q. If we could go to tab 39, please, Mr.  
15 Johansen, this would be interrogatory 9.21.129.

16 THE REGISTRAR: Which is .172.

17 ---EXHIBIT NO. 520.172: Interrogatory No. 9.21.129.

18 MR. FEDORSEN: Q. This is Hydro's  
19 response to a question put by Mr. Bourgeois:

20 Does Ontario Hydro see any  
21 similarities experienced by agricultural  
22 producers following the Lodgepole blowout  
23 and those reported by Bourgeois.

24 And if you read that article, I can  
25 assure you that some of the things that are talked

1 about in the Lodgepole situation --

2 THE CHAIRMAN: Why don't you ask him the  
3 questions, rather than give your commentary on the  
4 article.

5 MR. FEDORSEN: Fine.

6 Q. Do you see Hydro's answer?

7 MR. JOHANSEN: A. Yes, I see that.

8 Q. Did you hear what Dr. Whillans talked  
9 about with respect to at some stage keeping an hope  
10 mind, we have all talked about debates. This comment  
11 that there is no similarities, Hydro does not see any  
12 similarities between that, and the final line is, there  
13 is no documented sheep exposure during this event, it  
14 was cattle in Lodgepole, but this is sheep with  
15 Bourgeois.

16 THE CHAIRMAN: What is the question?

17 MR. FEDORSEN: Q. The question is this:  
18 Is that answer in your view as a scientist, in keeping  
19 with what Dr. Whillans just told us about fruit flies  
20 and open minds? Is it?

21 MR. JOHANSEN: A. Is it what?

22 Q. Is it in keeping with what Dr.  
23 Whillans just told us about an open mind, spirit of  
24 debate?

25 Hydro doesn't see any similarities

1 because in part --

2 THE CHAIRMAN: That question is  
3 argumentative. I don't think it needs to be answered.

4 MR. FEDORSEN: May I rephrase it?

5 THE CHAIRMAN: You can try.

6 MR. FEDORSEN: All right.

7 Q. Is the fact that Bourgeois has sheep  
8 dying and in the Lodgepole blowout cattle die, is that  
9 something that would lead you as a scientist to say  
10 that one is unconnected with the other?

11 MR. JOHANSEN: A. Well, without knowing  
12 the particulars, I would say one would need to look  
13 very carefully at the concentrations and times of  
14 exposure in each situation.

15 Q. Somebody wrote this answer that there  
16 is no similarities, it's not you because you don't know  
17 all that much about hydrogen sulphide, it's somebody  
18 else back in Hydro somewhere.

19 Can I ask his name, please, Mr. Chairman.

20 MR. B. CAMPBELL: Mr. Chairman, the  
21 answer is entirely consistent with what Mr. Johansen  
22 has said. It points out that there were high  
23 concentrations and long concentrations and that's the  
24 basis of the answer. It records the mere fact that  
25 there was no documented sheep.

1                   I cannot see what producing the name of  
2    each and every person who wrote interrogatories answer  
3    is going to be helpful to panel.

4                   MR. FEDORSEN: I thought if this was a  
5    debate I could at least write him a letter and ask him  
6    some questions off the record.

7                   THE CHAIRMAN: I am not going to force  
8    Hydro to disclose the author of that interrogatory.

9                   MR. FEDORSEN: Q. Now, cause and effect,  
10   Dr. Whillans, you would know a lot about that, as a  
11   scientist? Yes? No?

12                  DR. WHILLANS: A. I know something about  
13   cause and effect, whatever that means.

14                  Q. What you said yesterday was, it's  
15   worth looking for the cause if it can be -- if it's an  
16   important effect.

17                  We were questioning you there. I can  
18   give you the reference from yesterday's evidence.

19                  A. No, I will accept that.

20                  Q. You will accept that.

21                  When you get a lot of things that could  
22   create a pattern, as a scientist you would look at the  
23   pattern and then there are other parameters to see  
24   whether it's useful to investigate further; am I right  
25   on that sort of methodology?

1                   A. Yes. I think what I have been saying  
2         in several of these answers is that if you have an  
3         important effect that is not yet understood, then you  
4         look at factors that seem to correlate with it as a  
5         possible source of the cause. And if there is a  
6         pattern, then that also gives you some information.

7                   Q. If this Board were to hear evidence -  
8         and I am not going to go through all the dates because  
9         I am going to get objected to from counsel, I'm sure.  
10       Let me make it as simple as I can.

11                  If these Board hears evidence that not  
12         only sheep but a human being are experiencing symptoms  
13         that an expert will say are consistent with hydrogen  
14         sulphide exposure, and that when there are no gas  
15         releases in Hydro, those symptoms go away, would that  
16         evidence, Dr. Whillans, if we hear it, would it cause  
17         you as a scientist to want to make some much more  
18         detailed studies?

19                  A. Well, this is obviously a  
20         hypothetical situation. But I will accept that if  
21         there is a persistent concern about something which may  
22         be a result of something under our control, then we  
23         should be concerned to resolve it. I think as much as  
24         I have heard in the last two days, we do that to some  
25         extent. That's about all I can say.

1                   Q. Maybe not to the extent that even you  
2 would like when you said to some extent?

3                   A. I can't help you because I don't know  
4 whether -- we are talking about self-reported problems,  
5 we are talking about non-specific problems, and these  
6 are always problematic. And it may well be that this  
7 is valid, and if it is established that there is a real  
8 problem, then of course it should be followed up.

9                   Q. Let's take that a little bit more  
10 basic level. You had heard from Mr. Johansen that some  
11 of these hydrogen sulphide releases are, in fact,  
12 controlled; that is to say you know when, whatever the  
13 percentage of gas that's going to go out into the  
14 environment goes out, you know approximately when it's  
15 going to go out; right?

16                  A. I guess that's so. I don't know that  
17 from my personal knowledge.

18                  Q. And bear with me one moment.

19                  If you look at tab 12, Doctor, I am not  
20 going to read the first paragraph into the record  
21 because I haven't reviewed the tape, I can't say this  
22 evidence is accurate. I am not going read it in. I  
23 want to give you a hypothetical. If someone is  
24 complaining about hydrogen sulphide emissions and Hydro  
25 has the control of the timing, how onerous would it be

1 for Hydro to give warnings to the person complaining?

2                   MR. B. CAMPBELL: Mr. Chairman, this has  
3 been a matter that has been part of the discussions  
4 between Ontario Hydro and Mr. Bourgeois. It's an item  
5 which I am advised has received ongoing attentions in  
6 discussions between Lerner and Associates and Hydro's  
7 counsel. I cannot see how it helps the Board in any  
8 respect to get into the details of that particular  
9 situation. I just don't think it's relevant in any  
10 respect and it is tied up in this continuing threat  
11 that Hydro is under litigation in these matters.

12                   There is all kinds of operational  
13 considerations, as I understand it, that would come to  
14 bear and this has all been discussed with Mr. Bourgeois  
15 in completely different setting and I don't know how it  
16 helps the Board.

17                   THE CHAIRMAN: The question as I  
18 understand it, stripped of all it's rhetoric, is that,  
19 seeing that Hydro controls the hydrogen sulphide  
20 emissions, would it be a prudent thing to warn people  
21 in the neighborhood when this was being done. I'm not  
22 sure Dr. Whillans is the right person to answer that  
23 question, but is that an improper question in your  
24 view?

25                   MR. B. CAMPBELL: Mr. Chairman, my

1 concern is simply this: I don't understand how that is  
2 going to help the Board with its job, first of all.

3 THE CHAIRMAN: It's one way of perhaps -  
4 I don't know - controlling of the effect of emissions.  
5 And if Hydro witnesses have a view on it, maybe it  
6 would be useful to have that.

7 So I think the question in that way might  
8 be answered by somebody, if anybody has anything to say  
9 about it.

10 DR. WHILLANS: Well, Mr. Fedorsen's  
11 direct question was how onerous it would be, and that's  
12 an operational question, I have no idea.

13 MR. FEDORSEN: Q. Mr. Johansen?

14 MR. JOHANSEN: A. I can only refer you  
15 to a response to an interrogatory from your client,  
16 9.21.108 which does address that to some extent.

17 Q. I don't know if we have got that.

18 Hydro is giving warnings now or aren't  
19 they, of hydrogen sulphide emissions?

20 THE CHAIRMAN: No, no, that's not the  
21 question. The question was whether they thought it was  
22 a good thing from a safety point of view or  
23 environmental point of view to do that.

24 MR. FEDORSEN: I just don't have the  
25 interrogatory, Mr. Chairman. I don't know what he is

1 talking about.

2                   Sorry, I have got one now.

3                   Q. 9.21.108, sir?

4                   MR. JOHANSEN: A. That's the one.

5                   THE CHAIRMAN: Could we give that have a  
6 number, please?

7                   THE REGISTRAR: that will be .173.

8                   THE CHAIRMAN: Thank you.

9                   ---EXHIBIT NO. 520.173: Interrogatory No. 9.21.108.

10                  MR. FEDORSEN: Q. Let's read it out.

11                  Does the Board have this?

12                  THE CHAIRMAN: I don't have it in front  
13 of me. Is it long?

14                  MR. FEDORSEN: Not too long. I will  
15 stand by counsel here and --

16                  THE CHAIRMAN: No, no. He will trust  
17 you.

18                  MR. FEDORSEN: He has got it? Good.

19                  I am going to leave out the first two  
20 paragraphs, if wants me to read those in, I will read  
21 them in. I will skip down to the third line.

22                  Thus Hydro is always aware of when  
23 planned releases are going to happen.

24                  Hydro, of course, has no advanced  
25 knowledge of unplanned releases due to

1                   equipment failures, et cetera. Hydro  
2                   does not presently take any steps to  
3                   advise any members of the public of the  
4                   possibility of specific hydrogen sulphide  
5                   emissions from the plant. However,  
6                   general information is provided about the  
7                   possibility of releases of hydrogen  
8                   sulphide.

9                   And then they go on, and if my friend  
10                  wants to me to read any of that in, if I have in any  
11                  mislead what that answer --

12                  MR. B. CAMPBELL: I think it would be  
13                  useful to go with the balance of the paragraph, yes.

14                  MR. FEDORSEN: Fine.

15                  A warning system is in place as well  
16                  as emergency procedures designed to  
17                  protect the public in the event of a  
18                  major gas release. On an annual basis  
19                  literature is distributed describing the  
20                  possible harmful effects of exposure to  
21                  hydrogen sulphide and appropriate action  
22                  in the event that the warning horns are  
23                  sounded. The warning horns are tested  
24                  twice per year.

25                  Q. That's the position of Hydro, sir?

1                   THE CHAIRMAN: And the question is, why  
2 would you not also give specific warnings? Is that  
3 what your question is?

4                   MR. FEDORSEN: As to when the releases  
5 occur if they are controlled.

6                   THE CHAIRMAN: Yes, all right. That's  
7 the question.

8                   DR. WHILLANS: Mr. Fedorsen, I would  
9 point out that this is almost exactly what happens with  
10 respect to radioactive releases. There is general  
11 information, there is a warning system for serious  
12 releases and chronic releases are covered within other  
13 means.

14                  MR. FEDORSEN: Q. You are saying,  
15 Doctor, with all of your scientific expertise, from  
16 what you have heard of the evidence and the exchange  
17 between Mr. Johansen and myself, that you agree that in  
18 the case of hydrogen sulphide when you have got  
19 controlled releases, people shouldn't be told when  
20 those are going to occur? That's what you are agreeing  
21 with?

22                  DR. WHILLANS: A. That's not what I  
23 said.

24                  I was just pointing out that there is a  
25 system for providing information which is not unique to

1           hydrogen sulphide.

2           Q. Let me ask you directly. Do you  
3        agree or disagree with the fact that Hydro doesn't give  
4        warnings in controlled release situations?

5           A. That we do not?

6           Q. That's right. That's what the  
7        interrogatory says.

8           A. I can only tell you what the  
9        interrogatory says. I have no personal knowledge of  
10      that.

11          Q. You don't want to us whether you as a  
12        scientist agree or disagree with that even though you  
13        told you were interested in a debate over health and  
14        safety?

15          [11:12 p.m.]

16          THE CHAIRMAN: Now, let's stop the  
17        rhetoric, please.

18          MR. WHILLANS: Well, I'll say that I  
19        believe if there was a level of release which had  
20        potential to harm the public, then information would be  
21        given. That's what the warning system is for.

22          MR. FEDORSEN: Q. So the public gets to  
23        rely on the judgment of the people at Hydro whether  
24        there is any potential harm; that's your call.

25          DR. WHILLANS: A. No, I think these

1       levels are approved by regulators.

2                   Q. Back to the regulators again.

3                   A. It seems.

4                   Q. So your view would be, from what you  
5       have heard, that 20 parts per million on the  
6       Ministry -- 20 parts per billion on the Ministry of  
7       Environment monitors as they are presently constructed,  
8       monitoring over a half hourly or hourly basis, that's  
9       totally safe in all situations.

10                  THE CHAIRMAN: You don't have to answer  
11       that question.

12                  DR. WHILLANS: I can't help you with  
13       that.

14                  MR. FEDORSEN: Q. If you can't help me  
15       with that, Dr. Whillans --

16                  THE CHAIRMAN: I didn't say he can't help  
17       you. I said he doesn't have to answer it.

18                  MR. FEDORSEN: I thought he said he  
19       couldn't help me.

20                  THE CHAIRMAN: I said he didn't have to  
21       answer it.

22                  MR. FEDORSEN: All right. Fair enough.  
23       We have got till 11:30. Let's make it short.

24                  THE CHAIRMAN: We don't necessarily have  
25       until 11:30, because we have got other people waiting

1 to examine. I'm not restricting, I will make that  
2 clear, but I want you to stay on course, if you can.

3 MR. FEDORSEN: I said I'd be three hours  
4 and I think I'm pretty well right on course to the  
5 minute.

6 THE CHAIRMAN: I'm not quarreling with  
7 you about that, Mr. Fedorsen. I do think, speaking for  
8 myself, that you have wasted a lot of time, but that's  
9 my own view.

10 MR. FEDORSEN: Well, if there weren't so  
11 many objections, it wouldn't be this long with respect,  
12 Mr. Chairman. And if my questions are out of line --

13 THE CHAIRMAN: We are wasting time now.  
14 Carry on, please.

15 MR. FEDORSEN: Q. Mr. Johansen, if I  
16 might, we heard --

17 I don't know the lady's name from  
18 yesterday who was asking questions, Mr. Chairman.

19 THE CHAIRMAN: Well, there were two  
20 ladies asking questions.

21 MR. FEDORSEN: The one just before we  
22 started.

23 THE CHAIRMAN: That would be Mrs.  
24 deQuehen, I think. Mrs. deQuehen.

25 MR. FEDORSEN: Q. She was asking some

1 questions about mathematical modelling. At one stage  
2 she talked about some models actually giving answers  
3 that are 1000 times different than other models. Do  
4 you remember that evidence yesterday?

5 MR. JOHANSEN: A. In general terms. I  
6 know the subject was discussed. I don't recall that  
7 exact number.

8 Q. You heard yesterday that, at the very  
9 beginning when we were talking about the letter that  
10 was sent from Hydro to the Atomic Energy Control Board  
11 asking about their license, would you agree with me, as  
12 a scientist, that Hydro, from the point of view of  
13 licensing, has an interest in finding a mathematical  
14 model that says that is no hydrogen sulphide problem  
15 around the Bruce heavy water plant. You have an  
16 interest in finding such a model, would you agree or  
17 disagree?

18 A. Well, we clearly need to use such  
19 models. And whether time may show eventually that  
20 models that we currently use could be improved, time  
21 will tell. All I can say is that clearly we always  
22 want to use the best, most accurate models that we can  
23 get our hands on. And the subject of the safety of the  
24 heavy water plant, as in the case of all other nuclear  
25 facilities is the subject of ongoing review for

1       purposes of maintaining our license. ... And in the  
2       process of that review, models are reviewed and, if  
3       necessary, improvements are made, additional analyses  
4       are done. So the process is in place. It's not a fait  
5       accompli.

6                     Q. I already asked you about the process  
7       of warnings. I've asked you some things about Lumley.  
8       You can see, don't you, as a scientist, that Lumley is  
9       a world-class professor of engineering in aerodynamics.  
10      You know that:

11                   A. Well, I have no reason whatsoever to  
12       dispute that assertion. I don't happen to know  
13       Professor Lumley, personally, but from what has been  
14       said about him, I don't dispute that.

15                   Q. I put some propositions to you that I  
16       expect Professor Lumley will testify to in front of  
17       this Board. You wouldn't agree with them nor would you  
18       disagree, and I think that that's fair. I went through  
19       and, I think in the Chairman's eyes perhaps ad nauseum,  
20       on the one to four parts per million question.

21                   You know, though, that Lumley, whether  
22       you agree or disagree, will say that when you get peak  
23       concentrations of one to four parts per million because  
24       of the way these monitors are structured and time out  
25       on averages, when you combine that with the fractile

1 nature of the plume of gases that you can actually have  
2 right by the Bruce heavy water plant exposures of over  
3 100 parts per million of hydrogen sulphide gas, you  
4 know he says that that is mathematically possible,  
5 don't you?

6 MR. B. CAMPBELL: Well, just a minute.  
7 Just a minute. If my friend is going to put a question  
8 like that, first of all, I'm not at all sure of the  
9 answer. But I think that under that kind of  
10 circumstance, he has obligation to point out that the  
11 technical review that has been provided to him by  
12 Ontario Hydro raises some questions about Dr. Lumley's  
13 model and, indeed, in one case points out that they  
14 expect that Dr. Lumley may find, when he reviews this  
15 point, that some matters have been overlooked and he  
16 may want to consider that.

Now, my friend, in my submission, having obviously gone through this material and the witnesses not having had the opportunity to go through the material in detail, should, in fairness at least, point that out.

22 There is a full technical review of Dr.  
23 Lumley's assertions that have been put forward, and  
24 there are some questions raised in it. I think in  
25 putting the question, given when this material was

1 provided for these people who have been tied up in  
2 their appearance here, he, knowing this material as he  
3 so obviously does, is under an obligation to point that  
4 out.

5 MR. FEDORSEN: I wasn't going to hide it.  
6 That's why I filed the report.

7 THE CHAIRMAN: It's been pointed out, so  
8 now we have it. It's part of the question.

9 MR. FEDORSEN: I appreciate that. Could  
10 you answer the question, Mr. Johansen?

11 THE CHAIRMAN: What is the question?

12 MR. FEDORSEN: Q. You know that Lumley's  
13 mathematical model tells us, apart from any disputes  
14 maybe Hydro might want to take with him, that's fine,  
15 he tells us that, in effect, when you get a monitor  
16 reading on the monitors you use of 20 parts per  
17 billion, when you combine the problems with peaks along  
18 with the structure of plumes of gas that he says are  
19 fractile, that you can have mathematically dosages of  
20 over 100 parts per million around the Bruce heavy water  
21 plant, in this case on the Bourgeois farm. You are  
22 aware of that, aren't you?

23 MR. JOHANSEN: A. That appears to be  
24 what Professor Lumley has included. Yet simply looking  
25 at the concluding remarks from the review of Dr.

1 Edwards of our Research Division, there is obviously  
2 no consensus on that point. So, I mean, I am simply  
3 not in a position to offer any supportive comment on  
4 Professor Lumley's findings.

5 Q. Do you know why it is that the Hydro  
6 report, tab 59 --

7 Do you know why it was that when Hydro  
8 was going to take exception to Lumley in the report  
9 that's at tab 17 and also at 59, do you know why it was  
10 that there was a request that Hydro report -- this is  
11 at page two, sir.

12 A. At tab 17?

13 Q. Yes, sir. This line puzzled me. We  
14 would request that you not release his work to anyone  
15 without prior consultation to us. Do you know why they  
16 would say that? Why wouldn't they have forwarded that  
17 right away if this is all a concern for safety?

18 MR. B. CAMPBELL: Mr. Johansen is not the  
19 author of the letter. And in all fairness, Mr.  
20 Chairman, the reason for it is given right in the  
21 letter.

22 THE CHAIRMAN: What tab is it, I'm sorry?

23 MS. PATTERSON: Tab 17, page two.

24 MR. B. CAMPBELL: Dr. Weil did some work.  
25 He granted permission to use his work for the purposes

1 of discussion between Hydro and the AECB. And the  
2 author of this letter apparently felt that he should  
3 respect Dr. Weil's request and simply asked that Dr.  
4 Weil be contacted before the work be further released.  
5 It's stated right there.

6 THE CHAIRMAN: That's the answer to that.

7 MR. FEDORSEN: If that's the answer,  
8 fine.

9 THE CHAIRMAN: I think it's right in the  
10 report, too, that the other doctor didn't want his work  
11 used other than for in-house purposes.

12 MR. FEDORSEN: That's fine. If that's  
13 the answer, so be it.

14 Q. Last question, Mr. Johansen, is this:  
15 Would you agree that from what you know of hydrogen  
16 sulphide, when you gave your evidence here about how  
17 certain levels could affect people, and I appreciate  
18 you are not an expert, but from what you know about  
19 that, from what you have now told us you understand to  
20 be Lumley's mathematical model, that his mathematics  
21 explain the monitor readings that you are getting on  
22 hydrogen sulphide, they explain the characteristics and  
23 the symptoms that both Bourgeois and his sheep are  
24 experiencing on the farm, and they explain those  
25 things.

1                   THE CHAIRMAN: How could they do that?

2       Sorry. That's not within the area of expertise of Dr.  
3       Lumley. He just did a mathematical model, isn't that  
4       correct? Am I misreading it? He didn't talk about the  
5       cause and effect of the -- am I wrong about that?

6                   MR. FEDORSEN: Let me put it this way.  
7       Maybe I'm putting the question improperly, and then I'm  
8       going to be finished.

9                   Q. If you combine Lumley's mathematical  
10      model with evidence that you have read from  
11      Reiffenstein and effects of hydrogen sulphide, you  
12      would agree, as a scientist, that that combination of  
13      factors makes the world explainable in terms of your  
14      monitor readings and Bourgeois' complaints about  
15      hydrogen sulphide and the death of his sheep. You  
16      would agree with that as a scientist, wouldn't you?

17                  MR. B. CAMPBELL: Mr. Chairman, in my  
18      submission that question is quite unfair. Mr. Johansen  
19      has said that with respect to the modelling, with  
20      respect to that issue between Lumley and Dr. Edwards'  
21      report, that he has no basis personally. He hasn't  
22      reviewed the material closely. And perhaps even if he  
23      did, he has already clearly answered that he has no  
24      basis to say, to express an opinion on that, either the  
25      original report or the corrections that Dr. Edwards is

1 suggesting need to be made to the Lumley model. And  
2 this question is premised on accepting that Dr.  
3 Lumley's calculations correct. He already knows that  
4 Mr. Johansen can't accept that premise. It is my  
5 submission that the subsequent question is quite  
6 unfair.

7 MR. FEDORSEN: May I reply? I thought  
8 experts were to be asked hypotheticals. That's what I  
9 asked him. I asked if this were the case, does it  
10 explain the universe? That's all I'm asking.

11 MR. B. CAMPBELL: Mr. Chairman, the  
12 premise to the question, with which I agree, was that  
13 Mr. Johansen wasn't an expert. In my submission, if  
14 that's the premise of the question, then he can't give  
15 an opinion.

16 MR. FEDORSEN: If they don't want to give  
17 an opinion, that's fine with me.

18 MR. B. CAMPBELL: It's kind of a rule of  
19 evidence.

20 MR. FEDORSEN: I see.

21 THE CHAIRMAN: He says it's fine with him  
22 if he doesn't answer the question so we'll leave it at  
23 that.

24 MR. FEDORSEN: I thought he wanted to,  
25 actually.

1                   THE CHAIRMAN: He didn't get to.

2                   MR. JOHANSEN: I shook my head.

3                   MR. FEDORSEN: May I ask one last  
4 question?

5                   THE CHAIRMAN: Certainly.

6                   MR. FEDORSEN: Does anybody else on the  
7 panel want to comment in any way, shape or form over  
8 what I just said to qualifying to being a scientist?

9                   No comments, gentlemen? Thank you very  
10 much, gentlemen, for letting me question you. My  
11 thanks to the members of the Board for the privilege.

12                  THE CHAIRMAN: You made it right on time.

13                  MR. FEDORSEN: Thank you.

14                  THE CHAIRMAN: We are now adjourned until  
15 two o'clock or soon thereafter as I can be here. I  
16 hope I can be here by two o'clock. But I'll do the  
17 best I can.

18                  THE REGISTRAR: Please come to order.

19 This hearing will adjourn until two o'clock.

20 ---Luncheon recess at 11:28 a.m.

21 ---On resuming at 2:05 p.m.

22                  THE REGISTRAR: Please come to order.  
23 This hearing is again in session. Please be seated.

24                  THE CHAIRMAN: Ms. Harvie?

25                  MS. HARVIE: Yes. Mr. Chairman, on

1       Monday, May the 11th during Ms. deQuehen's  
2       cross-examination, I think it was Dr. Whillans made  
3       reference to the Annual Summary and Assessment of  
4       Environmental Radiological Data for 1991 and we  
5       promised you that we would produce a copy of that and  
6       file it, which I propose to do now.

7                   I've got eight copies for Mr. Lucas.

8       Perhaps we could have an exhibit number assigned to it.

9                   THE CHAIRMAN: Can we have an exhibit  
10      number, please.

11                  THE REGISTRAR: 677.

12       ---EXHIBIT NO. 677: Document entitled: Annual  
13       Summary and Assessment of Environmental  
14       Radiological Data for 1991.

15                  MS. HARVIE: In addition, I have spoken  
16       with Mrs. Young who - although she's not filed a  
17       statement of concerns for Panel 9 - has indicated to me  
18       that she would like an opportunity to cross-examine  
19       this panel.

20                  I don't take any objection to that. I  
21       explained to her that in the normal course that she  
22       would ask the Board for leave to cross-examine. I am  
23       not posing any objection to that, as I said, although  
24       we are anxious to finish by five or 5:30 today so Dr.  
25       Whillans can make his flight, and I have asked her to  
            bear that in mind.

1                   Thank you.

2                   THE CHAIRMAN: Thank you, Ms. Harvie.

3                   Ms. deQuehen.

4                   FURTHER CROSS-EXAMINATION BY MS. deQUEHEN:

5                   Q. Most of my questions are for Dr.  
6                   Whillans and I'm really just going to try to get  
7                   through as quickly as possible just in order to get a  
8                   response to certain issues which we will be raising  
9                   when we give our direct evidence.

10                  And everything I have said up until now  
11                  is just in those terms, I have just postulated things  
12                  and put things forward, I haven't actually -- nothing I  
13                  have done has been in terms of evidence or analysis, it  
14                  is merely just questions raised.

15                  With regard to DREF, a certain amount was  
16                  done with Mr. Campbell, the question was raised.

17                  DR. WHILLANS: A. Yes.

18                  Q. And you informed the hearing that  
19                  ICRP had suggested DREFs from 2 to 10 and BEIR from 2.5  
20                  to 4 or 5 in that range?

21                  A. Well, UNSCEAR was 2 to 10, the NCRP  
22                  document was 2 to 10, and I believe Mr. Campbell's  
23                  reference to another UNSCEAR was 1-1/2 to 3. But all  
24                  in that range, yes, and I think I said ICRP used a  
25                  factor of two.

1                   Q. Now, DREFs only apply if you are  
2       using the linear quadratic model; is that not so?

3                   A. Well, I think strictly speaking --  
4       well, first, we should understand I guess whether you  
5       mean by DREF the DREF with one D or two Ds because  
6       there's a question of dose reduction effectiveness  
7       factors and dose rate effectiveness factors.

8                   ICRP uses the acronym DDREF which  
9       includes them both. And it is simply that, it's a  
10      question of how you apply a risk number that's derived  
11      at high doses to low doses or high dose rates to low  
12      dose rates.

13                  Now, the ICRP model for solid cancers is  
14      linear and it has a slope, a risk for unit dose and  
15      they divide that by a factor of two.

16                  For leukaemia it's a linear quadratic  
17      equation not linear and that has an implied lowering of  
18      the effectiveness at low doses because of the shape of  
19      the curve. So they don't apply a DREF to that.

20                  So I guess if that's what you mean, I  
21      agree with you.

22                  Q. Well, what I am suggesting is that it  
23      is a correction for the dose response curve which is a  
24      net effect.

25                  A. Yes.

1                   Q. It has nothing to do with what the  
2 underlying reasons may be for that curve?

3                   A. Well, there is a suggestion about  
4 what the underlying reasons might be in the ICRP  
5 document, for example. I mean, the reason why it might  
6 be reasonable to apply a DREF is because of repair  
7 mechanisms that can operate more effectively at low  
8 doses or dose rates than they can at high acute doses.  
9 That's the unproven but speculative reason, I think.

10                  Q. But were that so, it would be  
11 demonstrated in the curve.

12                  A. Well, I think the problem is that we  
13 don't have a lot of data under those conditions. For  
14 statistical reasons basically it's very difficult to  
15 measure excess cancers when very small doses were  
16 received because it's an end effect which probably  
17 occurs in the absence of radiation, and so we are  
18 looking within other causes, I guess.

19                  Q. Could you turn to Gofman, Radiation  
20 Induced Cancer, 671.

21                  A. This is in your --

22                  Q. No, it's separate.

23                  A. Oh, okay.

24                  Q. No, it's not that one.

25                  A. No, I have it.

1 Q. It's one with two tabs.

2 A. Separate, yes.

3 Q. Chapter 22 which is just between the  
4 two tabs, I just want to refer you to this chapter, I'm  
5 not going to go into any detail I assure you.

6 A. Between the tabs.

7 Q. Between the tabs there's a Chapter  
8 22. It doesn't matter if you can't find it, I'm not  
9 going to --

10 A. I have it, yes, yes.

11 Q. The Popularity of Risk Reduction  
12 Factors in a Radiation Community. Now, there is a  
13 whole chapter on this, and I just want to ask you  
14 whether you are aware of the position which a lot of  
15 people take that it's inconsistent to use a linear  
16 model and apply DREFs, that it is both illogical and  
17 inconsistent?

18 A. Well, I would agree with you that if  
19 you have a linear model and you accept that the linear  
20 relationship applies for over the range, then it's  
21 illogical to reduce it at low doses. But that doesn't  
22 apply to low dose rates, so we have a mixture of  
23 effects here.

24 I would agree with you, if you assume  
25 that there's a linear model, then the same slope at

1           high doses applies at low doses.

2           Q. I thought in your direct evidence  
3           that you had stated that radiation cancer effects  
4           followed a linear dose model?

5           A. It's assumed by ICRP and we accept  
6           that, that there is a linear dose response for  
7           induction of cancer as a result of radiation exposure.

8           But what I'm saying is that a DREF as  
9           used by ICRP doesn't apply only to reducing the dose,  
10          it's also the question of reducing the dose rate and  
11          that's separate from whether or not it's logical to use  
12          a different slope when you have already assumed that  
13          it's linear.

14          So the DREF that's applied by ICRP with  
15          two Ds takes into account dose rate as well as dose and  
16          it's not really possible I think on the basis of the  
17          evidence now to separate those.

18          Q. Certainly. I don't want to argue  
19          with you, Mr. Whillans, I just want to put forward the  
20          position that is taken here and that is that were the  
21          reduction factor due to dose rate or low dose, it would  
22          still show in the net dose response which you use.

23          I'm merely just saying that is the  
24          position which I put forward and I understand that you  
25          don't accept it.

1                   A. Okay. Well, we can agree to  
2 disagree.

3                   Q. With regard to your position and  
4 acceptance of the linear model, could I ask when you  
5 actually adopted that position or whether you have  
6 absolutely adopted it with regard to cancer effects?

7                   A. Well, when you say you, are you  
8 speaking about Ontario Hydro?

9                   Q. I'm speaking of Ontario Hydro.

10                  A. Well, to my knowledge Ontario Hydro  
11 has always followed quite closely ICRP recommendations.  
12 And ICRP has used the linear model at least back to its  
13 1977 publication, and I'm not as clear about whether  
14 there was a specific statement earlier.

15                  Before the 1970s the emphasis was not as  
16 strongly on the importance of induced cancer as the  
17 major effect of radiation exposure at low doses and  
18 dose rates which is what we are concerned about.

19                  Q. My understanding is this, that the  
20 linear model was recommended by both BEIR and ICRP  
21 until 1977. In 1977 the quadratic and linear quadratic  
22 options were adopted in the face of a lot of  
23 controversy. With the case of BEIR 3 they were  
24 recommended and adopted.

25                  I don't know whether you know about all

1       the controversy that took place when those  
2       recommendations were adopted with Dr. Radford and --

3                     A. I'm aware of the problems that the  
4       BEIR 3 committee faced and the fact that there was  
5       controversy about linear or linear quadratic, the fact  
6       that some of the members of the committee felt it  
7       necessary to file independent reports, and I agree with  
8       you that it was controversial at that time.

9                     And, as I say, there's no unchangeable  
10      reason I think to expect that all cancers, for example,  
11      will follow the same dose response. Certainly in  
12      animals much more peculiar effects can be demonstrated  
13      because there are hormonal imbalances and things like  
14      that involved in certain kinds of cancer.

15                   I think what ICRP is saying is that the  
16      evidence for leukaemia suggests something other than a  
17      linear model, a linear quadratic, and for all of the  
18      other cancers together the evidence isn't statistically  
19      strong enough to prove anything other than linear,  
20      which is essentially the simplest or the simplest other  
21      than a constant factor.

22                   So I would agree with you that there's  
23      nothing demonstrated yet that proves the linear model  
24      is correct. I think I said in direct evidence --

25                   Q. I was really just referring to total

1           cancers.

2                   A. Well, there you have a complicated  
3                 situation because we are quite sure that leukaemia is  
4                 different.

5                   Q. I'm leaving out leukaemia, is what I  
6                 mean.

7                   A. Oh, other than leukaemia?

8                   Q. Other than leukaemia.

9                   A. Okay.

10                  Q. Solid cancers, I should have said,  
11                 pardon me.

12                  A. Okay.

13                  Q. Could you turn to reference 10 - and  
14                 I hope it's reference 10 because I've shuffled up my  
15                 references here. Oh no, reference 12.

16                  A. This is in your original package 677?

17                  Q. It's in the original package, I'm  
18                 sorry.

19                  A. This is the hormesis package.

20                  Q. Well, it's not actually. That's just  
21                 a little note at the top.

22                  A. Yes.

23                  Q. If you will just turn over to the  
24                 second page, I'm sure you are familiar with this  
25                 particular matter I would call it. This is the final

1 analysis of the new bomb victims evidence.

2 A. We are talking about Dr. Gofman's  
3 paper?

4 Q. Yes. These show clearly that with  
5 regard to solid cancers the curve is actually  
6 supralinear?

7 A. Well, this is Dr. Gofman's analysis.  
8 I have to say that other groups don't get the same  
9 result. As a matter of fact this is a letter to--

10 Q. Well, if you --

11 THE CHAIRMAN: Let him finish. Go ahead,  
12 Doctor.

13 DR. WHILLANS: --to the Journal of Health  
14 Physics in January of '89, there was a whole series of  
15 exchanges in the correspondence section of this journal  
16 over the years '89, '90, '91 between Dr. Gofman and  
17 others.

18 MS. deQUEHEN: Q. They are all here.

19 DR. WHILLANS: A. Yes. So I think that  
20 it is clear that there is some dispute about whether or  
21 not this is an accepted view.

22 Q. Well, I think there's an  
23 extraordinary amount of dispute and if you read all  
24 those letters which are here--

25 A. Yes.

1                   Q. --you will see how everyone is  
2       absolutely battling against acceptance of this model.

3                   A. Well, they are primarily letters from  
4       Dr. Stovall actually.

5                   Q. I beg your pardon?

6                   A. The contrary letters were primarily  
7       from one individual, Dr. Stovall, but I would say  
8       that --

9                   Q. There were from other people too.

10                  A. BEIR 5, for example--

11                  Q. They were from other people.

12                  A. --has a very different view.

13                  Q. Who has a different view?

14                  A. The BEIR 5 committee had a different  
15       analysis. This is the analysis which basically came to  
16       the conclusion that there was a linear relationship and  
17       UNSCEAR as well concluded that there was a linear  
18       relationship.

19                  Q. Not a supralinear relationship?

20                  A. Not supralinear, that's right. These  
21       are two views of what the data mean and Gofman's view  
22       is one of those.

23                  Q. So you accept that solid cancers are  
24       linear but not supralinear?

25                  A. I accept that that is the analysis

1 and the conclusions that the BEIR committee, UNSCEAR  
2 and ICRP, the conclusions they have come to and we  
3 accept their analysis.

4 Q. But you acknowledge that the linear  
5 quadratic is no longer -- there's no longer any  
6 evidence for the linear quadratic and yet you still use  
7 DREFs?

8 A. For solid cancers.

9 Q. Yes.

10 A. Yes.

11 Q. If we could just move on to the next  
12 package. Oh, there's just one more question I wanted  
13 to ask you on that. You said, when you were speaking  
14 to Mr. Campbell, I don't believe there's any question  
15 of using a dose increase factor. I think you said in  
16 response to --

17 A. I can't remember having said it, but  
18 I guess I would agree. I don't think there is.

19 Q. According to the analysis which  
20 Gofman and other people accept, if there was a  
21 supralinear curve you would indeed use a dose increase  
22 factor?

23 A. Yes.

24 Q. And I mean, they have said there is.

25 A. That's true, they do. I mentioned

1 one circumstance - which I don't think we need to go  
2 into - about neutrons where I think the general  
3 scientific community would agree that there may well be  
4 such an increase at low doses and dose rates, but that is  
5 not what we are talking about mainly.

6 Q. Well, as we are discussing it, are  
7 you aware of any research that has been done with  
8 tritium on low doses?

9 A. Yes.

10 Q. And what is the evidence?

11 A. Well, there are literally dozens,  
12 perhaps hundreds of papers on low dose response to  
13 tritium exposure. Which one in particular are you  
14 thinking about?

15 Q. Well, I just wondered what the  
16 overall evidence is.

17 A. With respect to the shape of the  
18 curve?

19 Q. With respect to whether a low dose  
20 rate -- I'm talking about low dose rate.

21 A. Yes.

22 Q. Whether a low dose rate effect can be  
23 found with tritium?

24 A. Well, tritium exposures are almost  
25 inevitably low dose rate as opposed to just acute

1 exposure because it requires somehow injecting the  
2 tritium into the animal and then the exposure occurs  
3 over days or so.

4 So that there really isn't a way of  
5 comparing directly with an acute exposure but, in  
6 general, I guess we should focus perhaps on something  
7 like induction of cancers.

8 There have been studies carried out at  
9 Chalk River and I think these were referred to in the  
10 interrogatory process looking at two kinds of cancer in  
11 animals, in rats and mice, comparing an exposure from  
12 tritium and from external x-ray radiation and these  
13 people found no significant difference between those  
14 two kinds of exposure.

15 Q. I'm afraid it's in the next package.  
16 There is an experiment by Little and Nove, I don't know  
17 if you know of that--

18 A. Yes.

19 Q. --which shows no low dose effect for  
20 tritium, and then there's a further experiment in which  
21 they look at dose rate, not for tritium, but for other  
22 radiation and find in fact that for low dose rate  
23 there's an increase in effect and a cross-over effect,  
24 but I hope I will have time to come to that because I  
25 think it's important.

1                   If I could just look at reference 16  
2       which I think is the experiment you are talking about,  
3       page 21.

4                   A. This is in your new package?

5                   Q. New package. That's the end of the  
6       old package.

7                   A. Do we need a number for this?

8                   THE CHAIRMAN: Hold it -- we should have  
9       a number I think for the blue package.

10                  THE REGISTRAR: No. 678, Mr. Chairman.

11                  ---EXHIBIT NO. 678: NEB Reference Package, 15-40G

12                  [2:25 p.m.]

13                  DR. WHILLANS: Yes, this is one of the  
14       studies to which I just referred.

15                  MRS. DEQUEHEN: Q. And I think the next  
16       one is just stapled behind, is it? Or 16. No, it's  
17       not.

18                  DR. WHILLANS: A. Yes. It's stapled to  
19       it.

20                  Q. This is just excerpts. It's not the  
21       whole study.

22                  A. Yes.

23                  Q. Page 21.

24                  A. Of the first study?

25                  Q. Of the first study.

1                   A. Yes, okay.

2                   Q. This shows the tritium dose response  
3                   curve.

4                   A. Yes.

5                   Q. Which really does show that it's  
6                   supralinear. On the other page, 22, I think you will  
7                   agree they have analyzed for linear kinetics and  
8                   managed to put a straight line through it. But if you  
9                   were not determined to turn it into a linear  
10                  relationship, I think you must agree that it shows it  
11                  is.

12                  A. I think we should clarify something  
13                  here. I assumed we were talking about low dose  
14                  exposures. This is what Gofman was discussing. It is  
15                  well-known, and this is true in UNSCEAR and BEIR, as  
16                  well, that even though it's assumed that there is a  
17                  linear response at low doses, at very high doses  
18                  probably as a result of cell-killing, there is an  
19                  ineffectiveness of the radiation and that results in  
20                  what you can call a supralinear response. That is not  
21                  part of the analysis that BEIR does or UNSCEAR. These  
22                  are very high doses. Cell-killing effects are  
23                  eliminated from their analysis. And we were talking  
24                  before, I assumed, about whether there was a  
25                  supralinear response at the low doses about which we

1       are concerned.

2                  You can see here that the smallest does  
3       in this study was one Gy, which would be approximately  
4       one sievert. And this is well above the range in which  
5       we have been talking about as low dose exposures.

6                  Q. So you say there is evidence in the  
7       range of low dose exposures, experimental evidence not  
8       just theoretical.

9                  A. Gofman says there is evidence in the  
10      range of low dose exposures. He is concerned that we  
11      are underestimating the risk at occupational or  
12      environmental doses. This is quite a different  
13      situation. I certainly agree with you that at these  
14      high doses, the response does bend over. And that is  
15      taken into account in the analysis.

16                  We were talking about whether between  
17      that first point, the one Gy and zero the response  
18      would be linear or still supralinear. I think that's  
19      what I wanted to clarify.

20                  Q. Yes. I understand that. But what I  
21      am saying is, you say there is experimental evidence in  
22      those exceedingly low ranges, which are the ones you  
23      are worried about, to show that there is a lower effect  
24      at low dose rate.

25                  A. Well, I don't know that I said

1 exactly that. But the assumption, based on animals --

2 Q. Yes, it's based on an assumption.

3 A. Well, it's based on animal studies

4 and common mechanisms, I guess, the repair system that  
5 I was referring to.

6 Q. Yes. Again, Dr. Whillans, to avoid  
7 argument, I merely want to establish the position that  
8 according to the position the government takes and  
9 other people, that this is not so and there is no  
10 evidence for it. But I understand.

11 A. I understand that is his position,  
12 yes.

13 Q. If we could just turn to reference  
14 15. I mean, all I really want to do is get your  
15 response and establish that as far as I'm concerned  
16 there is a open issue and these are the things we'll be  
17 dealing with.

18 Reference 15, quality factor for tritium  
19 radiation. Now, this is from tritium symposium by  
20 McGleshie and Carter.

21 A. 1973.

22 Q. It's 1971.

23 A. I think it was published in '73.

24 Q. Of course, yes. I think everyone  
25 knows this book, I think.

1                   THE CHAIRMAN: Excuse me. Everyone knows  
2 what?

3                   MS. deQUEHEN: I mean, in research  
4 everybody knows this book, I think. What I mean is  
5 that I'm sure Dr. Whillans knows this paper inside out.

6                   THE CHAIRMAN: Is that correct, Dr.  
7 Whillans?

8                   DR. WHILLANS: Well, inside out might be  
9 too -- but I have read the paper. But it is rather old  
10 information.

11                  MRS. deQUEHEN: Q. Certainly. But I  
12 just want to go back to the beginning because I think  
13 that biological effectiveness factor or quality factor  
14 "Q" is an important issue with regard to tritium. And  
15 I would just like to go back to where it was first  
16 established.

17                  DR. WHILLANS: A. Can I just say for the  
18 benefit of the Board that we have moved from the DREF  
19 factor to another factor entirely, which is a quality  
20 factor for tritium.

21                  MRS. deQUEHEN: I'm so sorry. I should  
22 have explained that. We are laying aside the DREF  
23 factor, agreeing to differ, and we are moving on to  
24 another fact about which there is a lot of controversy,  
25 as far as I am concerned.

1           Q. If I could just read these few lines.

2                         The International Commission on  
3                             radiological protection, ICRP, originally  
4                             recommended a value of 1.7 for the  
5                             quality factor "Q" of electrons with  
6                             maximum of "E" max less than 30 KEV.  
7                             This was based upon the LET and  
8                             experimental RBE values of tritium, the  
9                             only important nuclide in this energy  
10                           range.

11                         So originally, they had a factor of  
12                         tritium for 1.7. And then later, in view of  
13                         uncertainties inherent in the RBE values and in the  
14                         interests of simplicity, the "Q" was lowered to unity.

15                         Now, on the evidence on which this men  
16                         then reviews all the evidence and comes to the  
17                         conclusion that all the evidence says it should be 2 if  
18                         we just turn to the second leaf, on the left-hand side,  
19                         the relationship between LET and quality factor. This  
20                         is the theoretical evidence upon which it is based. If  
21                         you look on the horizon axis, you will see about 2,  
22                         between 1.7 and 2.3. It was theoretically where they  
23                         felt it should be. Now, if you will move to the third  
24                         page on the left-hand, where I think I have got a  
25                         yellow mark, he looks at all the variables which could

1       be involved.

2                   A. Sorry. This is Figure 2?

3                   Q. No, this is on the third leaf.

4                   A. Third leaf, sorry. Yes.

5                   Q. On the left-hand side.

6                   A. Well, my problem is I don't have the  
7       yellow mark.

8                   Q. I'm sorry. Where it says reference  
9       dose.

10                  A. Yes.

11                  Q. He looks at the variables of the  
12       reference dose, dose rate, gamma or X-ray, tritium  
13       dose, and he looks at all the work that has been done  
14       so far. He then has a summation on the fifth page, I  
15       hope I have marked them, at the bottom, this diagram  
16       here, where he represents in these little boxes the  
17       various values which people have got for the RBE at  
18       this time ultimately. And he puts in the range of  
19       those values, according to the variables, and as he  
20       says, it varies about two, not one.

21                  So the theoretical evidence suggests two.

22                  All the experimental evidence suggests that at this  
23       time it was two. But because of uncertainty and for  
24       simplicity, the ICRP decided it should be one.. Now,  
25       this is my question. If there is uncertainty, then in

1           the light of conservation you would choose the higher  
2         value. And as for simplicity, you don't alter the  
3         figures for simplicity in science, especially when it  
4         is something that is both hazardous and important.  
5         Could I ask your opinion of that type of result?

6           A. Well, those reasons, such as the  
7         interest of simplicity, are Dr. Johnson's  
8         interpretation of why ICRP changed. We could look at  
9         the actual statement that ICRP made when they did  
10        change it. And I think it basically says there was no  
11        evidence for a number different from one.

12           Now, with respect to the figure you show,  
13         figure 3, one of the important issues in this whole  
14         question is a factor relative to what? The problem  
15         with the evidence certainly up until this time was that  
16         some experiments were done using, say, 250 kilovolt  
17         X-rays. The standard X-rays that were used in a  
18         hospital, for that matter, or in a laboratory. Some of  
19         them were done with high energy gamma rays; cobalt  
20         would be typically the source. The problem is that  
21         those two reference sources have been shown to have  
22         very different effectivenesses.

23           They have a quality factor, essentially,  
24         of two. And so in some cases it wasn't possible to  
25         determine from experiments that were done, say, in the

1       50s and 60s in which a lot of this, in which the  
2       quality factor at this time was set, what the source  
3       was. And so there was uncertainty, primarily because  
4       of the reference source of radiation.

5                     Q. And may I ask what the reference  
6       source is now?

7                     A. Well, in ICRP's terms, it is a 250  
8       KVP, 200 to 250 KVP x-ray, essentially. It's the one  
9       which has the higher effectiveness and one for which  
10      tritium response is not very different. Now, I won't  
11      say that I think it's identical, but it's not very  
12      different. It is different from the cobalt gamma.

13                  Q. Now, so that is the reference.

14                  A. Well, ICRP has said that.

15                  Q. What about the -- Sorry.

16                  THE CHAIRMAN: Just a moment. Wait until  
17      he finishes, please.

18                  DR. WHILLANS: ICRP has suggested that  
19      that would be an appropriate reference for quality  
20      factors, yes.

21                  MS. deQUEHEN: Q. And how does that  
22      relate to cobalt gamma?

23                  DR. WHILLANS: A. Well, the  
24      effectiveness of a cobalt gamma radiation is  
25      approximately half. It depends on the end point. But

1 it is less effective because it has a lower LET.  
2 That's linear energy transfer. It's essentially a  
3 measure of how densely the radiation deposits energy in  
4 the cell.

5 Q. I am aware of that.

6 A. Right. I was just saying that for  
7 the Board.

8 Q. I'm sorry. I say I am aware of that,  
9 but the problem is that it has not actually distinctly  
10 related the cobalt to the X-ray reference. So, what is  
11 happening is cobalt is being treated as one, X-ray as  
12 one, as reference, and tritium as one. Whereas if you  
13 look in the reference, you will see that cobalt is  
14 actually half of the X-ray. And tritium, according to  
15 my view, is two or three, could be two or three of the  
16 X-ray.

17 A. Sorry. Now why do you say that?

18 Q. Well, I will get to that.

19 A. Okay.

20 Q. So, according to the evidence I am  
21 about to put forward, they're all being treated as one.

22 A. There certainly is a lot of  
23 confusion, I will agree with that.

24 Q. Well, it seems there's not only  
25 confusion, it is entirely illogical and unscientific.

1        And, I mean, surely, you know, it is a mess.

2                    A. Well, I think that the problem is  
3                    that in the practical situation, for example, in a  
4                    nuclear power plant, a worker isn't exposed to only a  
5                    high energy gamma or a 250 KV gamma or X-ray. He's  
6                    exposed to a range. And so practically, the  
7                    distinction becomes blurred. Now, I agree it's not an  
8                    entirely satisfactory situation. But I think that's  
9                    the reason there hasn't been a clear definition.

10                  ICRP has said reference radiation should  
11                  be in the order of a 200 to 250 KVP X-ray because that  
12                  was the system used to derive a lot of the data. But  
13                  that's not a common exposure in an occupational or an  
14                  environmental setting.

15                  So I think the reason there has been  
16                  confusion is because practically, it would not be  
17                  obvious what you would do with it if you did define it  
18                  differently. I guess I should make one other point,  
19                  actually. Until the two references that you have  
20                  provided as reference 16, the mammary cancer and  
21                  leukaemia study in animals, none of the previous  
22                  experimental measurements related to what we are  
23                  concerned about, which is the induction of cancer or  
24                  genetic effects, primarily at low doses and dose rates.  
25                  [2:40 p.m.]

1                   Most of the studies on which the quality  
2                   factor were based at the time it was changed, 1969,  
3                   were such things as the growth of bean roots in  
4                   culture, self-survival curves and so forth. They were  
5                   good indications of radiobiological effect but they  
6                   weren't necessarily what we wanted to measure.

7                   So I think one of the problems is that  
8                   much of this older data may not be directly relevant to  
9                   the problem that we have, and that's why we would tend  
10                  to rely more on more modern studies.

11                  Q. The reason I produced this odour data  
12                  was merely because I wanted to point out that in the  
13                  light of what was known then, they saw fit to reduce it  
14                  to one when at that time there was no evidence.

15                  If we could just move on to reference 16.  
16                  Now, I don't agree with you, that as far as I am  
17                  concerned a lot of experimental work has been done on  
18                  the RBE of tritium. I haven't got it all here.

19                  A. I agree with that, there has been a  
20                  lot done. But the RBE can be with respect to any kind  
21                  of input. If means relative biological effectiveness.

22                  Q. Absolutely. I do agree that this  
23                  should have been a good experiment because it was  
24                  chronic and long-term. If I could just move to the  
25                  back paper first, to page 642, this was the first paper

1       they did with mice?

2                   A.  Rats, actually.

3                   Q.  This was the rats and the other mice,  
4       I beg your pardon.

5                   Now this would have been a most  
6       interesting paper but it ended after 450 days  
7       presumably because they all died off.

8                   Do you think that is the reason?

9                   A.  Four hundred and fifty days is  
10      approaching the lifespan, I believe, of these rats, but  
11      I don't know that that was the case.  I haven't read  
12      this recently.

13                  Q.  But they all die off at the higher  
14      doses which suggests that they must have been having  
15      some radiological sickness or cytotoxic, and at those  
16      high dozens I really don't think that it's very  
17      physiological.

18                  A.  Well, I think that was range of doses  
19      used.

20                  Q.  They are still exceedingly high.

21                  A.  Half a Gy, one Gy, one and a half Gy.  
22      I am just looking off the graph on page 643.

23                  Q.  I want to ask you this, Dr. Whillans,  
24      with regard to the RBE for tritium, it is completely  
25      dependent on the dose rate -- not the dose rate, on the

1 level of the dose. At high doses--

2 A. And the dose rate, yes.

3 Q. --it falls off, and at low doses it  
4 increases?

5 A. The RBE does?

6 Q. The RBE?

7 A. Well, that may be in some cases, but  
8 the hope is that you will find a constant relationship  
9 because that's what you want to apply as a qualifier.

10 Q. Exactly. But it is a known  
11 biological fact with the RBE of tritium, would you  
12 admit --

13 A. I don't think it is just tritium. I  
14 think--

15 Q. Yes, but we are just talking about  
16 tritium.

17 A. --we are talking about defining --

18 THE CHAIRMAN: Hold it. It's very hard  
19 for the reporter to take everything when two people are  
20 talking at the same time. So when Dr. Whillans is  
21 talking, if you could just wait, and vice versa, that  
22 would be a big help.

23 MRS. deQUEHEN: I'm sorry.

24 ---Pause.

25 THE CHAIRMAN: I didn't know that would

1 be so effective.

2 DR. WHILLANS: Well, I think I was saying  
3 that what we are talking about here is essentially an  
4 operational correction factor. We don't know in detail  
5 yet the mechanisms by which these end results occur.

6 What has been attempted here,  
7 particularly in this case, is to measure for an end  
8 point, which although it's in a rat or mouse, is  
9 similar in some ways to what we are concerned about  
10 in man which is induction of a cancer.

11 Now, I should point out that both of the  
12 studies you have included in reference 16 which are  
13 virtually the only ones that have tried to address this  
14 relevance question have deficiencies. And so I don't  
15 think the issue is closed.

16 But I don't think the main problem with  
17 the one that we are talking about now, the mammary  
18 tumor data is that the doses were so high that they  
19 caused non-specific causes of death. The main problem  
20 with this system is that it is a highly susceptible  
21 system to mammary tumors.

22 Virtually all the female mice developed  
23 mammary tumors. All we are looking at here is the  
24 acceleration and time of that as a result of radiation.  
25 So clearly there is quite a lot of interpretation that

1 has to go into it.

2 MRS. deQUEHEN: Q. You, I am sure, are  
3 familiar with your own Canadian tritium experience.

4 DR. WHILLANS: A. I guess so, yes.

5 Q. Well, even in that way it is  
6 discussing radiobiological effects of tritium.

7 A. You are talking about the specific  
8 book?

9 Q. Yes.

10 A. Oh, I see. In general, yes.

11 Q. In there it states that tritium, the  
12 RBE of tritium is sensitive to dose and falls off at  
13 higher doses.

14 A. Perhaps we should refer to it. We  
15 may be talk about the cell-killing region. I don't  
16 know what you mean.

17 Q. Well, don't you think that these  
18 doses here are cell-killing regions?

19 A. .5 Gy?

20 Q. Yes.

21 A. No, not very much so.

22 Q. But what I am suggesting is they  
23 could be cell-killing and physiological effects.

24 Anyway, that's not such an important  
25 point.

1                   It seems to me that knowing there was  
2                   that susceptibility, if they wanted to find a low RBE  
3                   they would have done it at a high dose, if they wished  
4                   to find a high RBE they would have then moved down,  
5                   because even before this second study, the study at the  
6                   back here, if you analyze it, you can see the effect of  
7                   that.

8                   Now, if we just turn to the front study,  
9                   page 12. This was repeated for mice.

10                  A. This is quite a different study.

11                  Q. Absolutely.

12                  A. This is looking at the induction of  
13                  myeloid leukaemia and it's using mice, yes.

14                  Q. It's a different study, but it's  
15                  still looking for the RBE for --

16                  A. Yes. I think it was recognized that  
17                  the reservation that I made about the mammary study was  
18                  something that should be checked, and a second study  
19                  was done looking at another disease which occurs in  
20                  mice, which is similar to the disease that occurs in  
21                  man and is believed to be related to radiation  
22                  exposure.

23                  Q. But is it not true these studies were  
24                  done in order to find a reasonable RBE for tritium  
25                  which could be applied?

1                   A. Yes, that was the objective.

2                   Q. The first three columns are X-ray,  
3                   the next three columns are tritium, low dose, medium  
4                   dose, high dose, low dose, medium dose, high dose.

5                   The first vertical column at the top says  
6                   average radiation dose. Now it's about 1 about 2,  
7                   about 3, about 1, about 2, about 3, but not exactly?

8                   A. Yes, this is the simulation in this  
9                   study.

10                  This study is a more relevant end point,  
11                  but the doses that were given were too high and the  
12                  graphs that we looked --

13                  Q. So if the doses given were too high,  
14                  that would tend to make the RBE too low?

15                  A. If we are now talking about that  
16                  cell-killing--

17                  Q. Yes.

18                  A. --flattening off.

19                  Well, no, I think you are talking about  
20                  an entirely different mechanism. We are no longer  
21                  talking about what happens at low doses, so we are not  
22                  talking those stochastic effects.

23                  Q. No, no.

24                  A. So, I guess, I don't think you can  
25                  say whether or not the fact that the doses were it too

1       high would minimize the difference in the RBE. What it  
2       would do is make the whole interpretation pretty  
3       problematic because there essentially is not a linear  
4       response.

5                     Q. I could read at least 10 reports in  
6       literature where it says that the RBE of tritium is  
7       sensitive to dose level, falls off at high dose,  
8       increases at low dose, for different end points. But  
9       even for the end points this occur.

10                  I also have another paper where it  
11       says -- I won't get into just yet. I will deal with  
12       this.

13                  If I may read this and see what your  
14       response is to it.

15                  Volpez et al. were measuring for the  
16       RBE of tritium which increased as the  
17       tritium dose decreased. The RBE  
18       increased with decreasing dose up to 2.6  
19       at .25 Gy. The limiting value was done  
20       to 8 plus or minus 4.

21                  And then it goes on and on.

22                  Dobson and Kuan found increasing RBEs  
23       with decreasing tritium values.

24                  THE CHAIRMAN: I am sorry, where were you  
25       reading from?

1                   MRS. deQUEHEN: I haven't put this in.

2                   It is just something I happen to have with me.

3                   THE CHAIRMAN: It might help Dr. Whillans  
4                   if he is going to answer questions about it, if he  
5                   knows the context.

6                   MRS. deQUEHEN: It is just an example.

7                   All I am saying is there are very many  
8                   examples. It's almost a known fact.

9                   DR. WHILLANS: Well, I am familiar with  
10                  the Dobson paper, the series of papers, and we are  
11                  talking about become a very different system in that  
12                  case. We are talking actually about the loss of  
13                  oocytes in mice. It's not a stochastic effect. And I  
14                  also know he is talking about cobalt 60 as a reference  
15                  exposure. So the fact that it was relative biological  
16                  effectiveness of two doesn't surprise me.

17                  MRS. deQUEHEN: Q. Yes. I was really  
18                  just saying that he was says it's sensitive to dose  
19                  level. I have just read two, but I have come across a  
20                  lot of different ones.

21                  DR. WHILLANS: A. The fact that it is  
22                  sensitive to dose or dose rate in a system that is  
23                  quite distinct from a stochastic induction of cancer,  
24                  may or may not be relevant.

25                  Q. If I could just go back to this on

1       page 12. You can see I have written in some values at  
2       the bottom.

3                   A. Yes.

4                   Q. This is just taking the figure at the  
5       top, and this is not an analysis, Dr. Whillans, this is  
6       merely a postulate which I am putting forward.

7                   A. Yes.

8                   Q. I mean, naturally the analysis is  
9       more sophisticated than this. I am just proposing  
10      this.

11                  If you see cumulative incidence, and it  
12       is 0.72, 1.03, going across the bottom line, now taking  
13       that and just correcting for the radiation dose, so it  
14       is a cumulative effect per unit of radiation.

15                  A. So in the first case you divided it  
16       by 1.06?

17                  Q. That's right.

18                  A. Yes?

19                  Q. The next case I have divided by 1.98,  
20       okay?

21                  A. Yes.

22                  Q. Next by -- and so on. Just to get a  
23       per unit.

24                  A. Yes.

25                  Q. Now, I am treating -- so that it is

1 now closer to 1, 2, 3, 1, 2, 3 Gy's.

2 DR. CONNELL: Those numbers are not  
3 legible in my copy.

4 MRS. deQUEHEN: I'm sorry.

5 THE CHAIRMAN: We have got it now, all  
6 right.

7 MRS. deQUEHEN: I'm sorry.

8 Q. So now we have low, medium, high,  
9 low, medium, high. The first three figures are X-ray,  
10 the next three are tritium, to find the RBE at 1 Gy,  
11 the low tritium divided by the low X-ray gives you  
12 1.74, at medium the low tritium divided by the low  
13 X-ray gives you 1 at high, 1.

14 So this is really give exactly what  
15 everyone else is finding, that at lose dose the RBE is  
16 1.7 and it falls off at high doses.

17 DR. WHILLANS: A. But I have to ask you,  
18 if you look at figure 3 on the next -- well, it's  
19 actually page 21, and the lower part of the figure is  
20 essentially the same information.

21 The point I would make is, as I said, the  
22 doses used in this study were so high they were in a  
23 region where you can call it supralinear, I guess.  
24 It's supralinear only with respect to a line drawn from  
25 the last point to the origin. But in any case, this a

1       region where the dose response flattens off, and so I  
2       think it is not appropriate to calculate a dose --  
3       sorry, an effect per unit dose and compare them,  
4       because it's clearly not a region which is linear.

5                   Q. They have analyzed it on page 22, and  
6       there -- and said it is linear.

7                   A. This is not the same analysis,  
8       though.

9                   Q. No. But the fact is that at those  
10      comparative doses, I mean the difference is not really  
11      very much. The fact is what they find is that there is  
12      an RBE of 1.7 at lower doses.

13                  A. That's what you find.

14                  Q. Yes. But what they have done is just  
15      pooled these.

16                  A. I think I said at the beginning that  
17      I don't agree that this is strong evidence that the RBE  
18      is 1, because I think the doses chosen are the doses  
19      that were eventually used. Actually, there was a  
20      problem with the conduct of the experiment. The doses  
21      that were eventually given were inappropriate to  
22      measure the RBE. It was in a region where other  
23      effects than the induction of leukaemia were occurring.

24                  Q. But have you any idea why they used  
25      such high doses?

1                   A. As I said, one reason which I was  
2                   going to mention with respect to the mammary studies is  
3                   not to minimize the effect that would be seen, because  
4                   clearly anyone who understands the paper can see that  
5                   this has happened.

6                   The reason is that if you used extremely  
7                   low doses you would not have enough animals falling  
8                   susceptible to the disease to measure it, and that's  
9                   why doses closer to the tolerated limit should be used.

10                  Now, in this particular --

11                  Q. Of course --

12                  THE CHAIRMAN: Please, please, let him  
13                  finish.

14                  DR. WHILLANS: Excuse me.

15                  If you just turn over the back of page  
16                  22, there is an appendix A, and the report isn't shown  
17                  here, but it's called Dosimetry for the Myeloid  
18                  Leukaemia Tritium RBE Study. And the reason there was  
19                  a special appendix added was that during the study the  
20                  facility for exposure broke and they had to substitute  
21                  something else and this something else was not the  
22                  same. So to that extent I think the entire result is  
23                  open to some question.

24                  I don't think this is strong evidence  
25                  that the RBE is 1. Okay? I think I agreed with that

1 at the beginning.

2 There are flaws in both of these studies  
3 and there is still some question about what the RBE  
4 would be.

5 MRS. deQUEHEN: Q. What RBE do you use?

6 DR. WHILLANS: A. We use 1. And I  
7 haven't agreed that I think it should be 2.

8 Q. Well again I agree to differ because  
9 I think there is a lot of evidence that it should be as  
10 high has 3.

11 A. With respect to cobalt I would agree  
12 that it would be higher than 1. But that's not the  
13 reference radiation ICRP suggests.

14 Personally I believe the RBE may well be  
15 slightly more than 1, but I wouldn't say it was as high  
16 has 2, probably not as high as 1-1/2, but that's only  
17 based on information from a number of sources to do  
18 with LET relationships and so forth.

19 I would agree that it may well be  
20 slightly higher than one, but probably not anything  
21 like 2, and maybe only slightly higher than 1. And I  
22 don't believe there is any clear demonstration in a  
23 relevant system whether it is 1 or 2.

24 Q. Well, you are aware that Lawrence  
25 Livermore, Straume - I am afraid we will get to it

1       later - are now using 2.

2                   A. I don't know what they use.

3                   Q. And of course we will have to produce  
4       all our evidence on this, but it seems to me that it  
5       depends where you measure it. If you go down to, and  
6       it is at low chronic doses that we are interested in  
7       it, down there it could be exceedingly high. There is  
8       slightly no evidence that it isn't.

9                   A. Well, you are saying two things  
10      there. You are saying it could be high and there is no  
11      evidence that it isn't. I can say that there is no  
12      evidence that it isn't --

13                  Q. I am saying that it could be high.

14                  A. Yes.

15                  MS. HARVIE: Mr. Chairman, Mrs. deQuehen  
16      should not argue with the witnesses. She should put  
17      questions to them, get their answer and move on.

18      [3:00 p.m.]

19                  She has Dr. Whillans position on this  
20      paper and, in my submission, she should move on.

21                  MRS. deQUEHEN: I think we have moved on  
22      from that paper.

23                  Q. There is a lot of interest in the  
24      actual radiological effects of tritium--

25                  DR. WHILLANS: A. Yes.

1                           Q. --because tritium can be incorporated  
2                           into--

3                           A. Yes.

4                           Q. --DNA?

5                           A. Yes.

6                           Q. And there's lot of interest in  
7                           micro-dosimetry and the actual effects down at that  
8                           level, and there are a lot of theories which suggest  
9                           that tritium could act very like Auger electrons. I  
10                          don't know if you are aware of all this.

11                          A. Yes. The energy is different. I  
12                          think it could be quite different.

13                          Q. It could be.

14                          A. Auger results in a fragmentation,  
15                          essentially, of the radionuclide, it's quite different  
16                          from the emission of a beta particle.

17                          Q. But I am just saying that  
18                          theoretically, because of all these radiological  
19                          effects, do you perhaps agree with me that the RBE of  
20                          tritium may not only be governed by LET but there may  
21                          be other reasons for it being much higher?

22                          A. Well, you are talking here about a  
23                          specific situation, I presume, where the tritium is  
24                          incorporated into the DNA; is that so?

25                          Q. I am talking about the fact that it's

1 incorporated.

2 A. But into the DNA. An Auger emitter  
3 incorporated into some other part of the cell is not  
4 going to be particularly damaging to the DNA.

5 Q. I'm talking about tritium on the  
6 nucleus as target.

7 A. Right. And I'm sorry, your question  
8 was...?

9 Q. My question is this, that the limit  
10 of RBE -- do you believe that the limit of RBE may not  
11 only be governed by LET but could be much higher due to  
12 other radiological effects?

13 THE CHAIRMAN: Just a minute, Ms. Harvie.  
14 We will just get the answer to that and then we will  
15 move on to something else.

16 DR. WHILLANS: Okay. Well, for tritium  
17 incorporated into DNA, which I believe is what you  
18 mean, there are other effects as is the case for any  
19 nuclide incorporated into DNA.

20 But you asked if it would be limiting.  
21 The fraction of tritium that is taken into a cell or  
22 the body, say, as a result of tritiated water exposure  
23 which manages to get into DNA is small enough that this  
24 is not a limiting mechanism.

25 Now, if you are talking about a specific

1       chemical like tritiated thymidine which is a common use  
2       of tritium in a laboratory setting, that's a different  
3       situation.

4                             MRS. deQUEHEN: Thank you.

5                             THE CHAIRMAN: I think nothing you are  
6       going say this afternoon is going to change Dr.  
7       Whillans' mind that the factor is slightly higher than  
8       one but not as high as two. Would that be right?

9                             DR. WHILLANS: That's what I believe.

10                          THE CHAIRMAN: So there's no arguing with  
11       him about it. That's their position. He may not be  
12       right and there may be other evidence, but that's his  
13       position.

14                          MRS. deQUEHEN: I just want to see  
15       whether they are taking these effects into account,  
16       whether they are considering them, because they are  
17       generally being considered by a lot of other --

18                          Q. I think it's fair to say; is it not,  
19       that these effects are being looked at by a lot of  
20       research groups?

21                          DR. WHILLANS: A. Well, I'm having a  
22       little trouble just being sure what you mean when you  
23       refer to the Auger, you suggest to me that you are  
24       talking about tritium incorporated into the DNA and my  
25       answer to that was that is not a concern to us.

1 Now, there's the other question of organ  
2 bound tritium which you haven't mentioned, but you  
3 are --

4 Q. I haven't gotten to that yet.

5 A. You haven't got to that yet. That's  
6 not what you are talking about now. All right.

7 Q. Well, it is bound in the same way  
8 organic --

9 A. Then the answer I gave will stand.

10 Q. I'm talking really in terms of track  
11 lengths, because of the short track lengths and the way  
12 in which it has been compared to Auger electrons.

13 A. Well, that's what LET takes into  
14 account.

15 Q. Yes, but this is iron density and --

16 THE CHAIRMAN: I would think, if I were  
17 you, I would move on to something else.

18 MRS. deQUEHEN: Certainly.

19 THE CHAIRMAN: I think we have had enough  
20 of that for now.

21 MRS. deQUEHEN: Q. Are you familiar with  
22 the end track theory?

23 DR. WHILLANS: A. Sorry?

24 Q. Are you familiar with the --

25 A. End track theory?

1                   Q. Yes, or sometimes it's called the  
2 track end theory, but usually called the end track  
3 theory.

4                   A. Well, I don't know. Maybe you could  
5 tell me what you mean by that.

6                   Q. Well, it is a theory put forward by  
7 Goodhead and Nikjoo--

8                   A. Yes.

9                   Q. --that it is the last 5.7 KEV that  
10 really is responsible for biological effect, that the  
11 emission along the whole length of the track with  
12 regard to beta radiation is actually fairly ineffective  
13 compared to the last bout of radiation because it is  
14 moderated and slowed down at that point.

15                  A. All charged particles are more  
16 effective at the end of their tracks, yes, alpha  
17 particles, beta particles, high LET particles.

18                  Q. Certainly. But they feel this will  
19 have a great effect upon, and some other groups that  
20 this will have a great effect upon calculation of  
21 biological effectiveness.

22                  A. Yes.

23                  Q. Tritium being just the end will then  
24 be more comparative to other beta electrons.

25                  A. This is the kind of mechanistic study

1       that I referred to when I said that I believed the RBE  
2       could be slightly greater than one but probably not two  
3       based on those kinds of considerations, yes.

4                   Q. Well, are you aware that based upon  
5       these sort of considerations some people believe that  
6       it could be the order of 10 or more because the fact  
7       that tritium is considered such a weak type of  
8       radiation compared to another, is simply because it is  
9       multiplied proportional to its emission energy.

10                  A. A higher fraction of tritium's energy  
11       is deposited in the end track, as you call it, than for  
12       some other high energy emission. I agree with that,  
13       yes.

14                  Q. Now, don't you think that could have  
15       a great effect upon the final RBE and that is not taken  
16       into account at all.

17                  THE CHAIRMAN: I think he just said that  
18       he did take those into account; isn't that correct. He  
19       has taken those into account.

20                  DR. WHILLANS: These are theories, fairly  
21       recent theories and I believe they have been  
22       incorporated into ICRP's position for example.

23                  THE CHAIRMAN: I really think on this  
24       issue we have to move on, Ms. deQuehen. I think we  
25       have had enough. I think you have explored this very

1       fully and we have got Dr. Whillans' position on it.  
2       There may be another position, but that's for some  
3       other time.

4                   MRS. deQUEHEN: Q. If we could move on  
5       to organically bound tritium. I wonder whether it is  
6       something that you are concerned about?

7                   A. Yes, certainly Hydro is well aware of  
8       the importance of organic bound tritium.

9                   Q. When you discuss tritium you usually  
10      refer to the fact that it doesn't accumulate, has  
11      exceedingly short half life and that is so with  
12      tritiated water, 10 days, and it's flushed through the  
13      body.

14                  A. I think I also mentioned that we do  
15      include a dose factor in our tritiated water doses for  
16      retained tritium. It adds about 10 per cent to the  
17      dose that would be calculated just from the 10-day half  
18      life.

19                  Q. But you are aware that there are a  
20      lot of other groups who believe it could be as high as  
21      2, 3, 4 times, not 10 per cent?

22                  A. I think you are talking about  
23      ingestion of organic bound tritium now not the  
24      incorporation of tritium into organic bound forms.

25                  In other words, I was referring to the

1 situation where an intake occurs as tritiated water,  
2 some of that is incorporated into tissue and is  
3 retained longer than 10 days.

4 I think you are referring to a case where  
5 someone eats some sort of a vegetable which has already  
6 incorporated the tritium into an organic bound form; is  
7 that not so?

8 Q. It is indeed.

9 A. Yes.

10 Q. I am really thinking in terms of an  
11 environmental situation where the biosphere and  
12 hydrosphere could be contaminated with tritium through  
13 ground water contamination?

14 A. Yes.

15 Q. So that the vegetation is  
16 contaminated and it moves up the food chain and in that  
17 case there can be direct incorporation.

18 A. Yes.

19 Q. And in such cases the amount of  
20 organically bound tritium will contribute some -- it  
21 has been suggested will contribute from two to fourfold  
22 to the tritium dose conversion?

23 A. Yes, it has. The important problem  
24 here is that even in an environmental sample all the  
25 tritium is not organic bound tritium.

1                   If you think of a tomato, for example,  
2                   which has been grown in the presence of tritiated  
3                   water, most of that tritium is still in the form of  
4                   water. And so the important thing is to know what  
5                   fraction of the intake is organic bound.

6                   And I believe sponsored by the Atomic  
7                   Energy Control Board, a study has been under way for a  
8                   couple of years, carried out by the Atomic Energy  
9                   Canada Limited Research Group, Dr. Brown, to look at  
10                  that very question, what fraction of typical diet  
11                  around our stations or in general is organic bound  
12                  tritium.

13                  As I understand that report isn't  
14                  finished yet, but it's certainly an area which is of  
15                  concern in Canada because tritium is of special concern  
16                  and it's one which the AECB is addressing.

17                  Q. But would you say that it could raise  
18                  your tritium doses by fourfold, threefold?

19                  A. Well, that fourfold applies only to  
20                  that fraction which is organic bound tritium and that's  
21                  what we don't know. The belief is that it will raise  
22                  it somewhat but not fourfold. It will be some fraction  
23                  of that depending on how much turns out to be organic  
24                  bound tritium.

25                  Q. But a lot more than 10 per cent?

1                   A. Well, the 10 per cent was an entirely  
2 different situation.

3                   Q. Certainly. It's through tritiated  
4 water.

5                   A. I can't speculate, but it may well be  
6 a factor of one-and-a-half, maybe even two. I don't  
7 know.

8                   Q. But up to now you haven't included  
9 that factor in your tritium dose conversion factors?

10                  A. That's right, that's right, because  
11 up until now there is no evidence what the factor ought  
12 to be.

13                  There's a recommendation from ICRP as to  
14 what factor to use for organic bound tritium, but you  
15 still need to determine what fraction of the intake is  
16 in that form.

17                  Q. But it has been known --

18                  THE CHAIRMAN: Excuse me. What's the  
19 ICRP factor; do you know?

20                  DR. WHILLANS: Just one moment.

21                  It's not -- I'm referring to an ICRP  
22 publication from 1989 and I was hoping there would be a  
23 factor, but it's not quite that clear.

24                  They assume that 50 per cent of the  
25 organic bound tritium is retained with four times the

1 retention time, so I guess that would be a factor of  
2 two-and-a-half.

3 THE CHAIRMAN: A factor of  
4 two-and-a-half. And as I understand what you said, it  
5 may be that high, but...

6 DR. WHILLANS: Well, no, this is only for  
7 the fraction which is organic bound tritium.

8 THE CHAIRMAN: All right.

9 DR. WHILLANS: And it's still to be  
10 determined how much of a diet is in that form.

11 THE CHAIRMAN: I see.

12 DR. WHILLANS: So it won't be any higher  
13 than that. If it were entirely OBT, it would be  
14 two-and-a-half by the ICRP recommendation or Ms.  
15 deQuehen quoted another reference which suggested as  
16 much as a factor of four, but it's some fraction of  
17 that.

18 THE CHAIRMAN: That's got to be some  
19 fraction by reduction.

20 DR. WHILLANS: That's right.

21 MRS. deQUEHEN: Q. If you could just  
22 turn to reference 21.

23 DR. WHILLANS: A. I have that.

24 Q. It's been known since 1970 that  
25 tritium could accumulate as organically bound tritium

1 and that it could be a real hazard and it's been  
2 recognized by a lot of people. I just wonder why you  
3 have waited until now to do these studies and to  
4 correct for it?

5                   A. Tritium has been used in biological  
6 studies to label compounds for much longer than that.  
7 It's been known that it's a form of hydrogen that can  
8 be incorporated into tissues. As I said, in our dose  
9 calculations we do take that into account. This is the  
10 additional factor of 10 per cent.

11                  Q. You take the pathway through  
12 tritiated water which is a 10 per cent factor.

13                  A. That's right.

14                  Q. But the fact of incorporation of  
15 tritium through the food pathway, I mean, that has been  
16 studied because in the same book there are a number of  
17 different publications on the tritium pathway, tritium  
18 in clays and tritium in the aquasystem, and so the  
19 whole pathway has been known for 20 years.

20                  A. Well, I wouldn't disagree that there  
21 has been information for at least 20 years that  
22 suggests that organic bound tritium can be taken into  
23 the body by ingestion.

24                  The studies that I referred to are the  
25 final part of a series of studies the AECB has

1 sponsored which began in the early 80s. And I guess  
2 because we have no basis for using any particular  
3 factor we believe it will be somewhere between one and  
4 two-and-a-half.

5 We are talking only about the fraction of  
6 the environmental exposures due to ingestion of  
7 tritium, which is not the major source. If you look at  
8 our annual summary you will see that inhalation, skin  
9 absorption directly of tritiated water is the major  
10 source.

11 So we are talking about a small fraction  
12 of a significant but minor component of public  
13 exposure, and I guess the reason we haven't changed  
14 anything is because we are waiting to use an  
15 appropriate number rather than guessing.

16 Q. As we have got 21 in front of us,  
17 this is a study of a case that ingested tritium. It  
18 was followed for some 400 days, urine sampled -- sorry,  
19 it's on the first leaf of -- second leaf of 21, and the  
20 first 40 days shows that the tritium was flushed out of  
21 the water compartments and for another 400 days the  
22 urine continued to show an exceedingly high tritium.  
23 It took over a year to flush the tritium out of the  
24 subject who eventually died.

25 A. I haven't read this paper, sorry.

1 Q. Well, this is from --

2 A. No, no. I haven't read this paper  
3 lately, but my understanding is certainly this was a  
4 chronic exposure, quite a bizarre situation where  
5 people working with tritium carelessly ingested it over  
6 an extended period of time and accumulated huge burdens  
7 of tritium. It was in a factory that produces tritium  
8 luminous compounds I believe.

9 [3:20 p.m.]

10 But, I don't think that this is an acute  
11 exposure showing long retention. I believe it's a  
12 chronic exposure.

13 Q. My point was that it shows that the  
14 body can accumulate enormous concentrations of tritium.  
15 And when we first phoned Ontario Hydro, asking about  
16 tritium hazard, ourselves and the public and everyone  
17 was generally told that tritium is not hazardous  
18 because it's immediately washed out of the body in 10  
19 days, it can't accumulate. Now, that is not entirely  
20 correct.

21 A. Well, I don't know who told you that.

22 Q. Well, that is what, in general,  
23 people have been told. If I could just move to  
24 reference 32, which is the advisory committee on  
25 radiological protection, published in January, 1991.

1 Now, in this paper, and this is only excerpts of it,  
2 they argue for the case that tritium can only  
3 contribute 10 per cent. There is no suggestion in this  
4 paper that tritium could be incorporated.

5 A. Could you tell me where they say  
6 that, please?

7 Q. I think it's on page 9.

8 A. For example, at the bottom of the  
9 first full paragraph, I see the sentence, thus the  
10 increase in dose rate from the ingestion of fresh  
11 vegetables containing 70 per cent water and 30 per cent  
12 organic material, all uniformly labelled with tritium  
13 in an equilibrium situation should be about one third  
14 of the observed increase in dose rate due to OBT and  
15 tissues of animals fed dry tritiated alfalfa only.

16 So this doesn't answer your question  
17 directly. But certainly they are considering increases  
18 in the dose rate beyond that from tritiated water  
19 exposure only because of the ingestion of OBT.

20 Q. But up to this point, they haven't.  
21 If we could just turn to reference 27.

22 A. Yes.

23 Q. This group of people are the ones who  
24 have pursued this matter of organically incorporated  
25 tritium, true?

1                   A. This is one group, yes.

2                   Q. One group, certainly. But if we  
3 just, perhaps we'll just read the introduction.

4                   Various models have been proposed to  
5 describe the kinetics of tritium in the  
6 human body. Most widely accepted of  
7 these is Bennett's recompartment model,  
8 which has been adapted by national  
9 counsel and radiological protection.  
10                  So the NCR -- and he goes on to state  
11 that the NCRP, and this was in 1984, -- model is  
12 such...  
13                  And he analyses their model:  
14                  ...is such that it does not take into  
15 account the incorporation of tritium and  
16 that you need a four compartmental model  
17 with an exceedingly long half life, et  
18 cetera. So in 1985 --

19                  A. Excuse me. It says the NCRP model is  
20 presented in figure one. And figure one on page 504,  
21 does have two compartments which exchange with the  
22 water compartment, and these have longer half times of  
23 30 days and 450 days.

24                  Q. Yes.

25                  A. I think the NCRP model always allowed

1 for organic-bound tritium. The point of this paper is  
2 that it wasn't sufficient with three compartments to  
3 account for the data. The paper which they refer to,  
4 the NCRP report is actually 1979. So even in 1984 it  
5 was somewhat out of date.

6 Q. Well, his conclusion is, only the  
7 four compartment model was able to reproduce the -- age  
8 et cetera.

9 A. Yes.

10 Q. The fact is, that according to the  
11 model you have been using up until now, you have failed  
12 to take the organically-bound pathway into  
13 consideration.

14 A. The model for environmental  
15 exposures.

16 Q. Yes.

17 THE CHAIRMAN: That's a question, I take  
18 it, is it, that you failed to do that?

19 MRS. deQUEHEN: Q. Yes, it's a  
20 question.

21 DR. WHILLANS: A. Yes, we assumed that  
22 the doses from environmental exposure are due to  
23 tritiated water only and they take into account only  
24 the OBT that is produced in the body, not the  
25 ingestion, as we said before.

1                   Q. And is it not true that you further  
2 state there will be an equilibrium between organically  
3 bound and tritiated water compartments? You do not  
4 accept that you could have an accumulation over and  
5 above equilibrium?

6                   A. I think we may get into trouble with  
7 Dr. Connell if we were not careful with our words here.  
8 I think this truly is an equilibrium in this model, but  
9 I could be wrong. But we do allow for these long  
10 retentions, and I think that's what you mean by  
11 non-equilibrium situation.

12                  Even in the model figure 1, there is a  
13 compartment which has a half time of 450 days. So  
14 although it does release tritium back to the water  
15 compartment, it is very long retained. So I think the  
16 model does take into account the effect of  
17 incorporation and longer retention.

18                  Q. Is it not true that it does not take  
19 into account the direct incorporation but it must be  
20 broken down into the tritiated water compartment first?

21                  A. Yes.

22                  Q. Well, that is contrary to evidence.

23                  A. Well, that is the subject we talked  
24 about five minutes ago, the question of how much of the  
25 tritium intake is actually in that form. And once we

1 have determined that, then the factor we will apply to  
2 that will probably be the ICRP recommendation, which I  
3 think is a factor of 2.5. But that is going to be for  
4 some fraction of the ingested intake only.

5 THE CHAIRMAN: It looks to me as if you  
6 pretty well got Dr. Whillans' position on this  
7 particular subject. And I think perhaps if you have  
8 some other aspect of it to raise, I think you, perhaps,  
9 should move into another subject.

10 MRS. deQUEHEN: Q. Mr. Johansen, is it  
11 not true that tritium will also accumulate in the soil?

12 MR. JOHANSEN: A. In what sense do you  
13 mean accumulate?

14 Q. By becoming bound.

15 A. I would expect so.

16 Q. So that you could, I think you'll  
17 agree it's at a fairly low level, something like .032  
18 per cent per week. But within the life span of a  
19 nuclear reactor, you could get accumulation of bound  
20 tritium in the soil.

21 A. I can't verify the numbers you have  
22 suggested, but what you suggest is a reasonable  
23 concept.

24 Q. And it is dependent upon the humus  
25 and organic content, to a large extent. And if there

1       are substrates there, in which case their binding  
2       increases greatly.

3                     A. Sounds reasonable, but it's not an  
4       area that I am expert in.

5                     Q. Mr. Johansen, I presume that you are  
6       responsible for the environmental modelling--

7                     A. For purposes --

8                     Q. --around nuclear, around the CANDU  
9       reactors?

10                  A. I have a responsibility for the  
11       production of environmental impact assessments which  
12       incorporate the results of radiological environmental  
13       modelling and many other disciplines.

14                  Q. Yes. I just wanted to ask some  
15       questions.

16                  A. And I rely on the competence of  
17       people in the area of environmental radiological  
18       monitoring for that part. It's not an area that I am a  
19       expert and I have a working knowledge as required to  
20       coordinate such a project, but I am not personally an  
21       expert in it.

22                  Q. Sure. Just maybe could I ask you  
23       some questions on it? I mean, I'm not an expert on it.

24                  A. Go ahead. I'll do my best.

25                  Q. Is it not true it is absolutely

1 raining tritium around CANDU reactors?

2 A. Raining?

3 Q. Raining.

4 A. If there is tritium in the air and it  
5 is raining, then there will be tritium in the  
6 precipitation deposited, yes.

7 Q. Now, before bomb testing, tritium was  
8 something like two becquerels per litre, in that range?

9 A. I'm not certain of that.

10 Q. Now it is, in North America, five to  
11 seven becquerels per litre, in that range?

12 A. Well, the --

13 Q. At Pickering, the drinking water is  
14 17 becquerels per litre.

15 A. Well, you are suggesting a lot of  
16 numbers that may be true, which I'm not in a position  
17 to comment on. Perhaps if there is a specific  
18 question.

19 Q. I'm just asking you if those are  
20 about the ranges.

21 A. I really can't confirm that. We have  
22 done an analysis of the accumulation of tritium emitted  
23 from our power plants, all of our power plants to the  
24 Great Lakes, for instance. In the context of tritium  
25 and other naturally occurring radionuclides and

1           assessed how they compare.

2           Q. Have you any idea of the worst case  
3         scenario around Pickering of the annual Pickering --  
4         yes, annual tritium level in the rainwater?

5           A. Worst case scenario I am not familiar  
6         with. However, I can refer you to the annual  
7         radiological assessments--

8           Q. Yes, but I just want a range.

9           A. --which we have provided to you.

10          Q. What sort of range?

11          DR. WHILLANS: Mrs. deQuehen, in the 1990  
12         report, Exhibit 520.15, page 44, the tritium  
13         concentration and precipitation for a variety of sites  
14         around Pickering is given. And they average about  
15         1,300 becquerel per litre. And the drinking water, the  
16         average level tritium in supply plants at Ajax, Oshawa,  
17         Scarborough, Toronto, Whitby is in the range of 11 to  
18         91 becquerel per litre.

19          MRS. deQUEHEN: Perhaps if we could turn  
20         to reference 33(A) --

21          THE CHAIRMAN: Perhaps before we do that,  
22         could we take a break? We have been here for an  
23         hour-and-a-half. Could you give us some idea of how  
24         much longer you are going to be?

25          MRS. deQUEHEN: I don't know.

1                   THE CHAIRMAN: Well, I mean, this has to  
2 come to an end sometime. This can't go on  
3 indefinitely.

4                   MRS. deQUEHEN: Well, of course, I will  
5 be as long as I am given.

6                   THE CHAIRMAN: No. We don't try to do it  
7 that way. We ask you to conserve your questions and  
8 try and put them into some kind of a reasonable time  
9 limit.

10                  MRS. deQUEHEN: I will go as quickly as I  
11 can.

12                  THE CHAIRMAN: Will you be as late as  
13 five o'clock? That's what I'd like to know, or could  
14 you be finished before then?

15                  MRS. deQUEHEN: Well, I would take to  
16 five o'clock if I was allowed.

17                  THE CHAIRMAN: No, no, Mrs. deQuehen, You  
18 misunderstand what I'm saying. You have, no doubt, you  
19 have been telling us that you are going to take so long  
20 and it's been taking longer and longer and longer. And  
21 I just want to get some idea of when you are coming to  
22 the end of this cross-examination. Because, quite  
23 frankly, a lot of it is taking very much longer and we  
24 are not getting very far with it. It's not being  
25 terribly helpful to the Board, I have to say.

1                   MRS. deQUEHEN: Well, in that case --

2                   THE CHAIRMAN: Not all of it. There's  
3        been some good points made. But it's taking a long  
4        time.

5                   MRS. deQUEHEN: Well, I will take till  
6        five o'clock if that is all right.

7                   THE CHAIRMAN: Do you think you can be  
8        finished by then?

9                   MRS. deQUEHEN: I will finish at five,  
10      yes.

11                  THE CHAIRMAN: Mrs. Young, do you think  
12      you can manage with half an hour?

13                  MRS. YOUNG: Yes, I will manage with  
14      that.

15                  THE CHAIRMAN: All right. Fine. Thank  
16      you.

17                  THE REGISTRAR: Please come to order.  
18      This hearing will recess for 15 minutes.

19      ---Recess at 3:37 p.m.

20      ---On resuming at 3:55 p.m.

21                  THE REGISTRAR: Please come to order.  
22      This hearing is again in session. Be seated, please.

23                  MRS. deQUEHEN: I will try and zip along.

24                  THE CHAIRMAN: Thank you.

25                  MRS. deQUEHEN: Q. If you could just

1 turn to summary reference 33 page.

2 DR. WHILLANS: A. This is the 1989  
3 summary, 33A?

4 Q. It is the 1989 summary and I have  
5 used it because that was the summary which was current  
6 when the hearing started.

7 The middle column says average tritium  
8 concentration in precipitate. The average is 2,000  
9 becquerels per litre. Montgomery Rhode, which is the  
10 downwind average, 3,500 becquerels per litre, compared  
11 with a background of five to seven becquerels, this is  
12 an enormously high amount of tritium in the  
13 precipitation. This is why I feel it's so important to  
14 look at the actual dose estimate of tritium very  
15 carefully, and all the biological effects.

16 With this sort of dosage I believe that  
17 you could be contaminating the local hydrosphere and  
18 biosphere in the vicinity downwind of CANDU stations. I  
19 wonder if you could please respond to that, Mr.  
20 Johansen.

21 THE CHAIRMAN: Is this a more appropriate  
22 question for Dr. Whillans to answer?

23 MRS. deQUEHEN: Mr. Johansen.

24 THE CHAIRMAN: I don't know which one  
25 should be answering it.

1                   MRS. deQUEHEN: Well, it is the  
2       environmental one.

3                   THE CHAIRMAN: I think they can make up  
4       there own minds which one answers it.

5                   DR. WHILLANS: Well, let me say something  
6       and then Mr. Johansen can add to it.

7                   You asked a couple of questions. I think  
8       the point is in the annual summary, you have excerpts  
9       here, but there is a calculation of dose which is  
10      reviewed by the Atomic Energy Control Board, which is  
11      available for comment by the public, and those doses  
12      are a small fraction of background, not necessarily  
13      negligible but a small fraction.

14                  Now the question about contaminating the  
15       whole hydrosphere came up with one of the other  
16       intervenors, and UNSCEAR's position, for example, is  
17       that I think it was 90 or so per cent, maybe I should  
18       look up the exact number, but a very large fraction of  
19       the global dose to a tritium emission is deposited  
20       locally. And these are the numbers that we are  
21       summarizing in this report.

22                  MRS. deQUEHEN: Q. If you could just  
23       turn to reference 34. Does an Ontario Hydro CANDU  
24       plant require to be sited in the vicinity of, or on a  
25       freshwater lake, or large freshwater body in order for

1       the freshwater to act as a dilution sink? Could an  
2       Ontario Hydro plant be sited in any area without  
3       contaminating the hydrosphere and without affecting the  
4       biosphere or the self-sustaining environment of the  
5       population living within the vicinity and outside of  
6       the buffer zone.

7                          Now I ask four fairly similar questions.

8       Can people live on the land and off the land in the  
9       vicinity of a CANDU station without harmful health  
10      effects? I wonder if you could answer. I didn't get  
11      much of an answer, I wonder if you could answer that  
12      for me?

13                         DR. WHILLANS: A. Well, I guess, again,  
14      I would just point out that the levels of  
15      contamination, as you call it, we believe are  
16      reasonably small. And although the numbers in  
17      becquerel per litre may seem large, they don't  
18      contribute a large dose to the surrounding population.  
19      And these are our calculations but they are reviewed  
20      and approved by the regulator, and they are available  
21      for challenge by public groups.

22                         Q. Thank you.

23                         A. By the way, while I am speaking, the  
24      factor that UNSCEAR gives for the local contribution  
25      from tritium is a factor of 100 times that for the

1       global. So we are really talking about a local  
2       contamination problem.

3                     Q. It is certainly a local contamination  
4       problem, yes.

5                     I wonder if you are familiar with  
6       pathways analysis which Ontario Hydro uses? Are you  
7       familiar with the pathway analysis which Ontario Hydro  
8       uses in order to calculate the dosage?

9                     MR. JOHANSEN: A. Yes, in general. I  
10      spoke about that in my direct evidence.

11                  Just in follow up to your earlier  
12      question, I was looking for something to put the  
13      tritium in precipitation in context, and I believe I  
14      found it on the page just before the one that you  
15      referred us to, page 46 of your reference, 33A, second  
16      paragraph where it says tritium concentrations in  
17      precipitation are, in general, less than 2 per cent of  
18      the MPCW, that's the maximum permissible concentration  
19      for water which may be a supply of drinking water.

20                  Q. Thank you. I will get back to that  
21      point.

22                  Are you aware that in the pathway  
23      analysis, the source of drinking water is the lake  
24      water which is at 17 becquerels a litre, the actual  
25      pathway analysis sidesteps altogether the issue of

1 tritium in ground water and in precipitate?

2 DR. WHILLANS: A. Well, if I may answer.

3 Drinking water comes either from a public supply or  
4 from a well. And on a site-specific basis where water  
5 is derived locally, say, from a well, that's taken into  
6 account in the calculation of doses and in the derived  
7 emission limits.

8 Q. Thank you. But I think that I have  
9 inquired closely on this point and drinking water is  
10 always accounted for by lake water and it is a point  
11 that I will bring up.

12 But in fact of the pathway analysis  
13 completely sidesteps the whole pathway from tritiated  
14 precipitate.

15 A. But the intakes for the water supply  
16 plants are from the lake and the levels are measured  
17 actually in the plant.

18 So you may object that there are wells  
19 that we haven't considered, that is a separate  
20 question. But I think the water pathway for most  
21 people who use mains water is correctly accounted for.

22 Q. Dr. Whillans, that is in a position  
23 where you have a lake.

24 I am wondering whether the CANDU reactor  
25 would stand up to a general environmental analysis in

1       terms of worst case scenario?

2                     A. Is that a question?

3                     Q. Yes.

4                     A. I think that's too general a question  
5        to ask.

6                     Q. I'm sorry, I don't quite know what  
7        you mean by this question. This is what we are doing,  
8        we are doing an environmental analysis right now of  
9        nuclear generation. This is what is happening at this  
10      hearing, among other things.

11                  I am not quite sure what you mean, what  
12      information you want from them with respect to that?  
13      They have given testimony about what they have done  
14      about the environment and I am not sure I understand  
15      your question.

16                  MRS. deQUEHEN: I'm sorry. Should I  
17      rephrase the question to Dr. Whillans?

18                  Q. The pathway analysis is a  
19      site-specific analysis?

20                  DR. WHILLANS: A. Yes.

21                  Q. And it is dependent upon the fact  
22      that the lake is being used as a dilution sink for  
23      drinking water. Could such a general -- not a  
24      site-specific analysis, but a generic analysis in the  
25      unusual way environmental analyses are done, could that

1       be done without the remedy of the lake as a drinking  
2       water source, would it stand up to that analysis?

3                     A. Well, I think as a general answer, if  
4       there were different pathways you would have to do a  
5       different analysis, and it is possible if the plant  
6       were not located where it is, that certain pathways  
7       would have to be reduced. I think you have to specify  
8       a particular situation.

9                     MR. JOHANSEN: A. Mrs. deQuehen, we have  
10      in fact analyzed reactor concepts located in areas of  
11      the province other than right on the Great Lakes, and  
12      in that process determined the need for special  
13      environmental control measures, and they would vary  
14      from site to site.

15                  I might also point out that the structure  
16      of the pathway model used for radiological  
17      environmental assessment is not a fixed one. It is  
18      modified to suit the specifics of the situation. And  
19      in waste management assessments, the drinking or the  
20      well pathway is commonly the assumption used, is the  
21      drinking water pathway used. It's very site-specific.

22                  Q. So if we did a general analysis of  
23      people living in the vicinity on the land and from the  
24      land, off the land, in the sense of drinking the ground  
25      water and growing food around a CANDU reactor, you feel

1       that the CANDU reactor would pass that test?

2                     A. Well, the reactors, as presently  
3       sited, are assessed using models which reflect those  
4       site-specific circumstances. If we were to assess  
5       conceptually alternative locations, the models would  
6       need to be modified to reflect those site-specific  
7       circumstances, and the result, as Dr. Whillans has  
8       pointed out, might well dictate reductions in certain  
9       pathways which might in turn require procedural or  
10      equipment changes to what we might call a reference  
11      design.

12                  Q. Are you saying that given the level  
13       of emissions that these CANDU reactors are presently  
14       putting out, if they were sited generally without the  
15       lake as source of drinking water you would have to  
16       lower the emissions?

17                  A. Some pathways would be different, I  
18       would expect. And there might be some reductions,  
19       there might conceivably be some cases where pathways  
20       would be more lenient, so to speak. Very  
21       site-specific.

22                  DR. WHILLANS: A. Mrs. deQuehen, I would  
23       point out that for the critical group action for  
24       example, take Pickering for example, the contribution  
25       of the tritium in drinking water to the dose, the

1 maximum exposed person is only about 1 per cent, and  
2 that maximum dose is about 1 per cent of the limiter of  
3 background. So we are really are talking a small  
4 contribution even to the doses received by people  
5 around Pickering.

6 Q. Dr. Whillans, if we do a pathway  
7 analysis, I would like you to respond to this, just  
8 looking at the generic effects of a CANDU reactor on  
9 the environment, using the same emissions that are  
10 presently given, if we look at the effects on the  
11 environment and on the hydrosphere, biosphere and hence  
12 the critical group, we find that the critical dose is  
13 raised some 4 or 5 times, would you agree that that was  
14 possible? So instead of being .05, it's about .25,  
15 using your same pathway analysis.

16 A. Well, obviously we believe that the  
17 appropriate numbers are the ones that are contained in  
18 our report and approved by the AECB. So I don't know  
19 how you do your calculation. I can't really comment.

20 Q. Have you ever done such a  
21 calculation?

22 A. No, I haven't.

23 Q. I mean, Dr. Whillans, isn't it true  
24 that this CANDU reactor is being sold all over the  
25 world and according to a presentation you do take

1 global effects, and not just the effects here in  
2 Ontario, specific tests that you have, say you have  
3 responsibility about environment elsewhere, these are  
4 being sold to countries which possibly do not have the  
5 same site-specific effects, site-specific  
6 characteristics, is it not important that a thorough  
7 general assessment of the CANDU reactor should be made  
8 here at this moment?

9 THE CHAIRMAN: Just a moment. It may be  
10 important, and it certainly is, but I don't think it's  
11 an Ontario Hydro matter. It's more of an AECL matter.

12 These witnesses are just concerned with  
13 the circumstances surrounding a nuclear generation in  
14 the Province of Ontario. What the situation is in  
15 other countries, it may be pertinent to the ask AECL  
16 about but not these witnesses.

17 MRS. deQUEHEN: Q. Is Ontario Hydro  
18 concerned about the greenhouse effect?

19 MR. JOHANSEN: A. Certainly. Panel 8  
20 testified at great length I understand about that very  
21 subject.

22 Q. But Ontario Hydro wouldn't be  
23 concerned about the effects of CANDU reactor generation  
24 in other parts of the world?

25 A. Yes. But I guess the easy answer is

1       that is not our responsibility. We can't control how  
2       they are operated or regulated.

3                     If you are suggesting that somehow any  
4       one of our present reactors ought to be able to perform  
5       the way it performs where it's located anywhere in the  
6       world, I'm not sure that we have a useful answer to  
7       that.

8                     Q. I am also asking you whether it is  
9       possible using another analysis other than the pathway  
10      analysis, whether you might not get a much higher --  
11      there are a number of different analyses which you  
12      could use, is that not right? You have chosen the  
13      pathway analysis?

14                   THE CHAIRMAN: What analysis are you  
15      referring to?

16                   MRS. deQUEHEN: There are a lot of  
17      different models they can use.

18                   Q. Is it not true that if you had chosen  
19      another model you could -- and a more typical model you  
20      would get 10 times higher the dose?

21                   DR. WHILLANS: A. I think we can agree  
22      that a more typical model would give a higher dose  
23      because we believe the models we are using give  
24      reasonable doses.

25                   These models are consistent with the

1 models published by the CSA Committee which developed  
2 these sorts of things, and with different site-specific  
3 parameters they are used at all our sites.

4 Q. There isn't time to look now, but I  
5 did have CFF--

6 A. TP.

7 Q. --TP document here where it ran a lot  
8 of different models through, and some of the models  
9 gave effects which were 10 times higher, so that is a  
10 very -- with the same criteria which you have.

11 A. Well, I don't know which models you  
12 are talking about, but presumably we are not using them  
13 because they are not appropriate for some reason or  
14 other.

15 The models that we do use have been  
16 submitted to the AECB who are aware of these other  
17 models presumably, and have decided that these are  
18 reasonable.

19 MR. JOHANSEN: A. In fact, we would  
20 require AECB concurrence if we proposed to change them.

21 Q. I am just suggesting this to you  
22 because you may wonder why I am wasting all this time.  
23 But it seems to me -- I will just leave aside the other  
24 model.

25 But if you take into account that ground

1 water contamination using your model, it would make  
2 your worst case up to 25, and using your own figures I  
3 could do this, using this Bush paper here which I  
4 haven't got time to do.

5 [4:15 p.m.]

6 I am then suggesting that your RBEs could  
7 be as high as three and stretching it I could make --  
8 just in the literature as it stands make a better case  
9 for three than one.

10 THE CHAIRMAN: I think we are going back  
11 to where we were a couple of hours ago, and I think you  
12 certainly can bring that evidence forth when the time  
13 comes, but I think Dr. Whillans' position and that of  
14 Ontario Hydro is pretty clear on his measurements here.

15 MS. deQUEHEN: Well, perhaps I could just  
16 summarize.

17 Q. Organically bound tritium, I believe,  
18 could be affecting -- the fact that you haven't taken  
19 it into account I believe could be reducing your dose  
20 assessment again by a factor of three at the outside, I  
21 believe the fact that you use dose reduction factors  
22 which are not warranted could be reducing your dosage  
23 again by two, and all these factors which I have  
24 discussed throughout and use a slightly different  
25 model, I believe - I haven't got the time now obviously

1 to give it - could be all multiplied together.

2 There hasn't been the time for me to go  
3 through it painstakingly, could be multiplied up to a  
4 factor of about 50. I believe you could be  
5 underestimating your tritium value by 50. I wonder if  
6 you could respond to that?

7 DR. WHILLANS: A. Well, as I have said,  
8 I don't know what factor it would be because I don't  
9 believe that some of those differences are appropriate.

10 Q. Of course, but if we multiply .2  
11 millisieverts by 50, it would come out to 10  
12 millisieverts which is 10 times the limit of the Atomic  
13 Energy Control Board?

14 A. Actually twice the present limit.

15 Q. Twice the present limit?

16 A. Yes.

17 Q. But there has been talk, and  
18 certainly at the beginning of this hearing, there was  
19 talk of reducing it to one.

20 A. That's right.

21 Q. So when you say your levels around  
22 nuclear plants are 0.1 of the DRL, I believe in fact  
23 that there is a good case that could be made for them  
24 to be at least 10 times the DRL?

25 A. Well, I don't agree.

1 Q. Of course.

2 THE CHAIRMAN: I think --

3 MS. deQUEHEN: And I'm sorry it's taken  
4 so long to make, but I do think it's an important  
5 point.

6 THE CHAIRMAN: You can make the case, but  
7 this is not the time to make it, is what I'm trying to  
8 tell you. There's a time to make that case but this is  
9 not the time.

10 MS. deQUEHEN: Yes. I'm sorry, I was  
11 just trying to get their responses to see how they  
12 responded to each of those factors because I think that  
13 the dose from the plant is exceedingly important in  
14 terms of the hazardous effect of tritium.

15 Q. I'm just going to fly through this.  
16 It doesn't matter about this because I will go so  
17 quickly that --

18 THE CHAIRMAN: Well --

19 MS. deQUEHEN: Unless you would like one.

20 THE CHAIRMAN: Well, it's up to you.  
21 It's your decision. I think probably it's helpful to  
22 have the documentation you're referring to.

23 Another exhibit number?

24 MS. PATTERSON: Exhibit 679.

25 THE REGISTRAR: 679, Mr. Chairman.

1                   THE CHAIRMAN: Thank you.

2        ---EXHIBIT NO. 679: NEB Reference Package, 41-59.

3                   MS. deQUEHEN: Q. I just wanted to raise  
4                  the question of mutagenesis, wondering whether you are  
5                  involved in it to any extent, interested in it as an  
6                  alternative method of assessment and regulation?

7                   DR. WHILLANS: A. Well, I'm not  
8                  particularly involved in it, but it represents a  
9                  mechanism for one or more of the stochastic effects  
10                 that occur at low doses. So, yes, I'm interested in  
11                 it.

12                  Q. You recognize that it is a field that  
13                 is really rushing forward and there seem to be an  
14                 enormous amount going on and that the aim is to set up  
15                 data banks in order to assess toxicity and toxic  
16                 effects of a lot of agents including radiation?

17                  A. Generally, yes.

18                  Q. At the cellular level.

19                  A. Yes.

20                  Q. If we could just look at 42, 44,  
21                 these are just publications of what is happening in the  
22                 field of toxicity, of toxicity control and  
23                 environmental protection.

24                  I had hoped in fact we could get an  
25                 expert from this field because it does present an

1       alternative way of actually assessing radiological  
2       damage; would you agree with that.

3                   A. Alternative to what?

4                   Q. Alternative to epidemiological  
5       studies.

6                   A. Oh, these are forms of mechanistic  
7       studies which provide alternative information, yes,  
8       they have limitations as well.

9                   Q. I'm sure they have limitations, but  
10      they do have the advantage that you can look at the  
11      direct effect of the radiation upon the system and you  
12      can pick up cellular lesions and all the different  
13      characteristics which are then set out as frequency  
14      spectra, and you can pick up effects at a level far  
15      before cancer and death, you don't have to use that as  
16      an end here?

17                  A. It's a much simpler system, yes.

18                  Q. Much simpler, much more sensitive  
19      because--

20                  A. Usually.

21                  Q. --you can bioassay at that level?

22                  A. Yes.

23                  Q. I'm sure you are aware that it hasn't  
24      actually come to fruition yet, that it's still in the  
25      process of being developed?

1                   A. Well, some systems like the Ames  
2 system have been in use for quite a long time.

3                   Q. Are you familiar with reference 45?

4                   A. I'm not familiar with this particular  
5 reference but I am familiar with the glycophorin A  
6 method.

7                   Q. And this was developed by people at  
8 Lawrence Livermore National Laboratory.

9                   A. Yes.

10                  Q. And you were aware that they have  
11 used it in the field in the Brazil accident and  
12 apparently they have also done testing at Chernobyl?

13                  A. Yes, and also of some of the  
14 Hiroshima/Nagasaki survivors, I believe.

15                  Q. Do you believe it might be -- I mean,  
16 I wasn't able to continue in what I was involved, but  
17 the dose assessment process seems to really be running  
18 into trouble.

19                  Do you believe this could, when  
20 developed - which I'm sure will be in the very near  
21 future - be an alternative way of actually assessing  
22 radiation damage sooner, more efficiently, quicker so  
23 that we will know exactly what is going on?

24                  A. Well, there are a number of, I guess  
25 you would call them genetic tests, chromosomal tests

1       that are being developed which have a variety of  
2       characteristics. The advantage to some of them is that  
3       they measure accumulative life-long exposure. They are  
4       just being developed and the problem with most of them  
5       now is that they are not sensitive below about 20  
6       millisieverts, so they are not useful for a typical  
7       environmental assessment. They are useful for those  
8       groups that you talked about who receive quite high  
9       exposures.

10                   Q. Yes. This 46 is a paper by Puck.

11                   Are you familiar with it, the work of Puck and Waldron.

12                   A. No, I'm not familiar with this paper.

13                   Q. But you are familiar with their work?

14                   A. I would say generally, no.

15                   Q. Well, they have developed a much more  
16       sensitive process, a much more sensitive cell type  
17       which will give effects, and they have been able to  
18       measure down at very low levels and since this - this  
19       was in 1986 - but since this they have worked on  
20       different cell type medium - and I had hoped Dr. Puck  
21       might be able to come -- he was coming, but he is not  
22       now - and the conclusion of this is that being able to  
23       monitor down at very sensitive levels they have found,  
24       or their conclusion is that radiation might be 200  
25       times greater than had previously been thought because

1       they have moved away from what you call the  
2       cell-killing region down to a more physiological region  
3       and to the regions which you are really interested in  
4       for chronic exposure.

5                   Do you think that as we are now sitting  
6       looking to 25 years ahead, you know, planning for the  
7       future that it might not be very important to include  
8       this type of work in this hearing and to think in quite  
9       different terms and perhaps just leave the old war  
10      horse of the ICRP aside and try to develop something  
11      which is already going on?

12                  A. Well, I really don't have any comment  
13       on this paper, but I think it would be unwise to  
14       disregard the advice of a large group which represents,  
15       I would say, the consensus of international knowledge  
16       on radiation effects. That's certainly our view of the  
17       ICRP.

18                  That's not to say that there won't be new  
19       developments. I mean, Ontario Hydro is supporting the  
20       Health and Welfare Laboratory cytogenetics laboratory  
21       in trying to introduce some of these new methods  
22       because we occasionally do have the need for biological  
23       dosimetry and we are certainly aware of that issue, but  
24       I don't think I can carry this as far as to, say,  
25       abandoning ICRP.

1                   Q. Right. But don't you think  
2 perhaps -- I mean, a lot of this work is done on  
3 radiation often as the reference agent to whatever they  
4 are testing, so there is an awful amount being done  
5 anyway. Don't you think you might be caught up in it?

6                   A. I'm not sure what you mean by caught  
7 up. I think we should be aware of it.

8                   Q. Don't you think it's going to  
9 converge on regulation because there is such an  
10 interest in environmental protection, in cancer  
11 research, and all these areas which are looking to this  
12 field of molecular mutagenesis and as it develops and  
13 if it becomes an efficient and sensitive process, then  
14 surely you will take advantage of it.

15                  A. Well, as I said, I think we should be  
16 aware of this and these are very specialized areas. I  
17 think what we have to do is find reliable groups which  
18 are aware of the implications and rely on their advice.

19                  Q. If we just look at 47, this is from  
20 the IICPH, a submission to the Ontario Nuclear Safety  
21 Review and it just talks about certain of your Ontario  
22 Hydro -- if we look at the second last paragraph, about  
23 the middle, it says the fact that Ontario Hydro --  
24 anyway, it talks about an accident but there isn't time  
25 to read it.

1           It talks about an accident victim who had  
2   certain genetic tests done because of an exposure and  
3   he was told that the level of mutations was average for  
4   an Ontario Hydro worker. Do you do such tests?

5           It's on the first page there, 55. I just  
6   can't find it now.

7           A. Sorry.

8           Q. Page 55.

9           A. 55.

10          Q. No, maybe I'm wrong. I beg your  
11   pardon, it's on the last page, the last paragraph.

12          THE CHAIRMAN: I'm sorry, who is this  
13   making this report?

14          MS. deQUEHEN: The IICPH and it's a  
15   submission to the Ontario Nuclear Safety Review, 1987.

16          And it says here, although the men were  
17   told by Hydro spokespersons that these chromosomal  
18   findings merely reflect their years of work at the  
19   nuclear generator.

20          DR. WHILLANS: Well, I presume you are  
21   referring to a situation a number of years ago in which  
22   some Ontario Hydro workers asked to have their  
23   exposures verified by cytogenetic methods and to my  
24   memory, samples were drawn by our medical department  
25   and sent to a number of sources, one of which is the

1       Canadian National Health and Welfare lab, one of which  
2       was the private lab that does cytogenetic analysis, did  
3       at that time for Ontario Hydro, and one of them was  
4       sent by Dr. , I believe, to Roswell Park and the  
5       specifics were medically confidential, so I don't know  
6       the details.

7                   Q. I'm not really interested --

8                   A. But I think the point was, my  
9       understanding was there were very few aberrations found  
10      by the two laboratories that we sent samples to in any  
11      of the workers, and that's why this report was given to  
12      them.

13                  Q. So you wouldn't confirm this, that  
14      these chromosomal findings merely reflect their years  
15      of work.

16                  I mean, have you any evidence that the  
17      Ontario Hydro workers do have chromosomal mutations or  
18      any level of detectable --

19                  A. Well, it's well known that exposure  
20      to radiation causes chromosomal abnormalities and so a  
21      worker, if he happened to have received a large dose  
22      over his lifetime, would probably have detectably  
23      higher levels than someone who was not exposed, and I  
24      don't know what the exposure of these workers were.

25                  Q. Sure.

1                   A. But it would not be unexpected.

2                   Q. So do you have a program to evaluate  
3                   the chromosomal effects, chromosomal aberrations of  
4                   your workers, or...

5                   [4:35 p.m.]

6                   A. There have been a number of programs  
7                   over the years. There isn't a great deal of enthusiasm  
8                   for them at the moment because the present methods that  
9                   are available aren't sensitive enough to detect the  
10                  changes that we would see in our workers. Remember  
11                  that the average exposure of our worker is about two to  
12                  three millisieverts a year above background. So even  
13                  over a long period of time, and most of these methods  
14                  do not integrate over long periods of time, we would  
15                  not expect to see.

16                  Q. Are the workers aware that they may  
17                  be getting these effects, that it may be --

18                  A. Every atomic radiation worker by law  
19                  is required to be given information about the  
20                  biological effects of radiation. They are given  
21                  lectures. They are shown some video material. And  
22                  they are asked if they understand that there are  
23                  certain effects of radiation exposure. And I'm sure  
24                  every worker now is given that information.

25                  Q. Reference 48. This is chromosome and

1       aberrations in human spermatozoa after in vitro  
2       exposure to tritium beta rays. Are you aware of this  
3       paper?

4                     A. I have not read this paper, no.

5                     Q. Are you aware of it?

6                     A. No.

7                     Q. Well, if you look at the third last  
8       line it says the RBE values range from 1.89 to 300.  
9       What they found was a positive effect of tritium on  
10.      spermatozoa.

11                  MS. HARVIE: May I just correct you? It  
12       actually says 3.0, not 300.

13                  MRS. deQUEHEN: Did I say 300? I'm so  
14       sorry. My mistake. I beg your pardon.

15                  MR. WHILLANS: A. That's part of the  
16       myeloid leukaemia study that we were talking about, I  
17       guess, before the break. The chromosomal analysis  
18       matters was done of the animals and particularly an  
19       analysis of aberrations in spermatozoa. And we don't  
20       have the full report here. But my memory is that there  
21       was not an RBE as large as this. It was not different  
22       from one. That's part of the full report that you gave  
23       us some excerpts on.

24                  Q. Oh, yes. This is just an excerpt.  
25       These are all just excerpts. I would just like to move

1 to this Stress of Life by Hans Sellier, reference 5- --  
2 I am sorry. Do you have it?

3 A. Fifty-four, yes.

4 Q. Yes. I just have introduced this  
5 because I think this is another aspect of radiation  
6 which is tremendously important. Low level chronic  
7 stress syndrome, which in view of the continuous  
8 chronic natures, nature of radiation in the vicinity of  
9 the plant could be tremendously important and it does  
10 tie up with a lot of biological research which is going  
11 on.

12 I do believe, I don't know if you will  
13 agree with this, but I think that when the paper on  
14 Chernobyl was presented and stress was mentioned, do  
15 you think perhaps they were talking about effects of  
16 chronic stress, which is a fairly complex biological  
17 process rather than just dying of fright?

18 A. Well, the summary of the  
19 international Chernobyl project, for example, that we  
20 looked at did talk about stress probably being  
21 responsible for many of the perceived health effects.  
22 But this was not stress as a result of direct radiation  
23 exposure, it was radiophobia was the word that they had  
24 used.

25 Q. Radiophobia?

1                   A. Yes.

2                   Q. Now, was that paper actually the  
3 publication of World Health Organization?

4                   A. No. The international Chernobyl  
5 project was administered, I guess, by the IAEA.

6                   Q. Because there probably was a  
7 representative of World Health there. But I don't  
8 believe it was one of their publications. The  
9 transmissions seem to give the impression that it was.  
10 If you could just turn to Gofman, second tab.

11                  THE CHAIRMAN: I'm sorry, I didn't pick  
12 that up. What did you say?

13                  MRS. deQUEHEN: I'm sorry. I beg your  
14 pardon. 671.

15                  THE CHAIRMAN: All right. Fine. Thank  
16 you.

17                  MRS. deQUEHEN: Q. Now, the pages aren't  
18 labelled. I don't know if you can find table 24(a).

19                  DR. WHILLANS: A. I'm afraid I haven't  
20 found 671 yet. Okay. Never mind.

21                  Q. Second tab, after the second tab.

22                  A. After the second tab on what page?

23                  Q. It's table 24(a).

24                  A. I have it.

25                  Q. Column C, fatal cancer yield.

1                   A. Yes.

2                   Q. Column D, Chernobyl induced fatal  
3                   cancers. I just point this out because a number of  
4                   studies have been done on the possible fatal cancer  
5                   yield. The NCRP study suggests 14,000. The DOE,  
6                   28,000, etc. This is estimated fatal cancers that will  
7                   occur. Gofman, because he uses much higher dose  
8                   conversion factors gets a much higher number.

9                   I think that during Mr. Hamer's  
10                  cross-questioning, I think this came up whether any  
11                  studies had been done and whether, you know, estimates  
12                  had been made. I just wanted to know if they had.

13                  A. Actually, I thought I had told Mr.  
14                  Poch that the range of estimates was from several  
15                  hundred thousand to 20,000 lives saved, actually, by  
16                  people who believed that low doses of radiation are  
17                  good for you. And I said that I thought that both  
18                  extremes were just that. There really is no good basis  
19                  for making these estimates at the moment.

20                  Q. Well, these are estimates made by the  
21                  Department of Energy and NRC, which is roundabout  
22                  30,000 or so not saved and not a minus 30 at risk.

23                  And these figures, he uses the same dose,  
24                  radiation doses as the others do but derives at it  
25                  differently. But these figures for all the radiation

1       doses were monitored by the World Health Organization  
2       which has done a lot of very useful work there. I just  
3       felt they should be distinguished, there should be a  
4       distinction drawn between the useful work they have  
5       done and the results of that other paper.

6                     A. The World Health Organization

7       certainly has been active around Chernobyl since the  
8       accident, yes.

9                     Q. With regard to monitoring of tritium,  
10      and I am just concentrating on tritium, we have looked  
11      at it very closely and there are an immense number of  
12      problems which there isn't time to go into. We were  
13      sent this reference 55. It's at the end of the one  
14      package.

15                    A. I have it.

16                    Q. This describes a lot of the problems  
17      that do occur. I mean, what I am asking you is, are  
18      you, is Ontario Hydro, itself, aware that there are  
19      problems with the molecular safe method?

20                   A. Well, this is an Ontario Hydro  
21      report.

22                   Q. You say it is.

23                   A. I believe so.

24                   Q. Yes. Well, I am just merely pointing  
25      out that this is one of your reports. And it appears

1 to me --

2 THE CHAIRMAN: That's understood, is it,  
3 that that's an Ontario Hydro report?

4 DR. WHILLANS: It's the Environmental  
5 Protection section of the old RMEP Department, I  
6 believe.

7 THE CHAIRMAN: And it was done in 1982?

8 DR. WHILLANS: Yes.

9 MRS. deQUEHEN: Q. And there were a lot  
10 of recommendations made. And it seems that not very  
11 much -- in the report they then look a few years later  
12 to see if any of their recommendations have come into  
13 effect, and not many had.

14 But all I'm asking you is, is the  
15 situation such that you yourself are aware of problems?

16 A. You are asking me if I believe there  
17 are problems in the monitoring of tritium around the  
18 stations?

19 Q. Yes.

20 A. I believe the present system probably  
21 could be improved but it's adequate. And in addition,  
22 the monitoring of tritium around the stations is  
23 carried out by independent groups such as Health &  
24 Welfare Canada.

25 Q. I'm just thinking how to phrase this

1 next question. I have just been to see Health &  
2 Welfare Canada. And if two groups use exactly the same  
3 method and the method is inherent in the group, sorry.  
4 If two groups use the same method and the problem is  
5 inherent in the method, then the groups will get the  
6 same errors, is that not so?

7 A. Generally, that would be true.

8 Q. If we could just go to reference 57.

9 On the third page, not the third leaf but the third  
10 page of the writing, the figure at the bottom.

11 A. Reference 57?

12 Q. Reference 56. Now, are you familiar

13 with this research?

14 A. Generally, but not in detail. I am  
15 aware that it has been done and I think I have probably  
16 even read the report but I'm not familiar in detail.

17 Q. Well, a number of different  
18 international agencies participated, did they not?

19 A. Yes.

20 Q. And they have all got various  
21 initials.

22 A. Yes.

23 Q. Ontario Hydro, a Japanese group, Los  
24 Alamos -- I don't even know where that is. French.

25 A. Yes.

1                   Q. Israel.

2                   A. Yes. Savannah River, yes.

3                   Q. If you turn to page 1162. The groups  
4                   that looked at tritium oxide, there are four of them,  
5                   two used the molecular sieve method. Two used the  
6                   bubbler method. I don't know. Have you got the green  
7                   and yellow speckles.

8                   A. No, I am afraid I don't have any  
9                   speckles.

10                  Q. Yes?

11                  A. I have circles around some "Xs."

12                  Q. No. Oh, because I thought I had  
13                  coloured them in.

14                  [4:50 p.m.]

15                  THE CHAIRMAN: 1162 was colored, but 1161  
16                  is not coloured. What page are we on.

17                  MRS. deQUEHEN: Q. On the third page.  
18                  Anyway, it doesn't matter, but the result of this is  
19                  that the two who used you are methods, and these are  
20                  international agencies who obviously their own methods  
21                  of monitoring tritium, the two used your methods were 5  
22                  to 15 times lower than the others. I think this  
23                  indicates that your method could be monitoring by a  
24                  factor of -- 10 to 15, I haven't got all the evidence  
25                  because there are a lot of other things --

1 DR. WHILLANS: A. I am not even sure .  
2 which two you are talking about. But our methods are  
3 reviewed by the regulator.

4 I wouldn't have thought it was difficult  
5 to measure tritium in tritiated water and I would be  
6 surprised if there was a serious problem.

7 Q. Well, I have even in your own  
8 publications come across things which says the bubbler  
9 is much more accurate, although it has its problems  
10 too, it underestimates because the tritium -- but what  
11 I am saying is this is indicative of your monitoring.

12 A. But you haven't shown me anywhere  
13 where this factor of 10, did you say, discrepancy  
14 occurs?

15 Q. Sorry, I thought I colored them all  
16 in.

17 A. The problem is that 1162 comes before  
18 1161.

19 Q. I'm sorry.

20 A. I'm sorry, I can't comment any  
21 further.

22 MR. PENN: A. Are we looking at table 2?

23 Q. Yes.

24 A. It shows to me Ontario Hydro Research  
25 division uses a nine chamber method, unless I am

1 misunderstanding this table.

2 Q. No, you are not. But the thing is  
3 that was for tritium, not tritium oxide.

4 A. So you are comparing AECL's numbers;  
5 are you.

6 Q. I am just looking at tritium oxide.

7 If we could move to Canadian Tritium  
8 Experience, a CANDU reactor contains several hundred  
9 tonnes of deuterium, I think.

10 DR. WHILLANS: A. Maybe Mr. Daly could  
11 help you here.

12 Q. Thank you.

13 MR. DALY: A. It contains about 500  
14 megagrams of heavy water.

15 Q. Megagrams. And that into tonnes is?  
16 Cubic tonnes?

17 A. That is a metric tonne.

18 Q. Metric tonne, sorry.

19 A. Yes.

20 Q. Five hundred metric tonnes?

21 A. Yes.

22 Q. Thank you. If you turn to page 8,  
23 where it gives mature escape rates, would you say, Mr.  
24 Daly, that --

25 THE CHAIRMAN: What was that, I'm sorry?

1 MRS. deQUEHEN: Page 9.

2 THE CHAIRMAN: Of what document?

3 MRS. deQUEHEN: Canadian Tritium  
4 Experience.

5 THE CHAIRMAN: Is it here?

6 MRS. deQUEHEN: It is the one I gave you  
7 when -- this one.

8 THE CHAIRMAN: I see. All right. I have  
9 got it, thank you.

10 MRS. deQUEHEN: Q. The leakage rate, I  
11 work that out to be about over 120 metric tonnes per  
12 year. Would that be about right? That a fifth of your  
13 heavy water leaks out each year?

14 MR. DALY: A. No, the makeup is  
15 something like 21 megagrams per year. So I think your  
16 figure sounds a bit high.

17 Q. Twenty-one, not 121.

18 A. The more typical leak rate that we  
19 have had recently is about 3 kilograms per hour per  
20 unit.

21 Q. I see. Because I am using 14  
22 kilograms per hour per unit.

23 A. It's a little high based on our  
24 recent experience. It is, I see, an estimate here. Of  
25 course most of the heavy water that is released is

1                   collected and put back into the system.

2                   Q. Yes. A fair percentage would leak  
3                   out each year but then be put back.

4                   A. Would be upgraded, cleaned up and put  
5                   back into the system.

6                   Q. To what extent do you use vapour  
7                   control and dryers?

8                   A. Quite extensively throughout the  
9                   reactor building, reactor vault, any area where there  
10                  is expected to be a concentration of heavy water or  
11                  water vapour in the area which is basically the reactor  
12                  building.

13                  Q. Because this Canadian Tritium  
14                  Experience has pages on vapour control, and when I sent  
15                  interrogatories to try and find out something about it,  
16                  the only answer I got was we can -- I said what is your  
17                  policy, because it seems so much is dependent on it in  
18                  terms of emissions.

19                  A. I think the key point on that was  
20                  that the key thing is, as you say, the emission and Mr.  
21                  Johansen and others have provided the tables with the  
22                  emissions and the records of emissions.

23                  The records of dryer performance are  
24                  largely internal at the plant. As I say, most of the  
25                  heavy water that is released is collected and put back

1       into the system on a regular ongoing basis routine.  
2       And I guess, basically speaking, anything that is  
3       abnormal or significant is tracked. The dryer  
4       operation is a routine run-of-the-mill operation. For  
5       equipment that's operating routinely, there is no need  
6       for extensive records.

7                   Certainly records have to be kept of  
8       emissions and those are of well tracked.

9                   Q. Would you be able to provide me with  
10      anything on your records and methods and everything  
11      related to vapour control?

12                  A. I really couldn't offer anything that  
13      hasn't already been offered via the interrogatories.

14                  Q. If you could turn to page 10 of this  
15      document, it shows here escape, and underneath  
16      recovery, and it suggests that 95 per cent of the  
17      vapour which escapes is recovered?

18                  A. That's correct. The function of the  
19      dryers and the associated collection system is to do  
20      just that.

21                  Q. If you are to ensure that 95 per cent  
22      of that vapour is recovered, do you not need a very  
23      formal system, implementation system whereby you ensure  
24      that 95 per cent is collected?

25                  A. Well, we have accounting systems for

1 heavy water and those figures here have been produced  
2 based on those accounting systems. So the leak rates  
3 and losses of heavy water are tracked.

4 However, what is not tracked, and I think  
5 the level of detail you are looking for is the  
6 individual dryer performance, there is several dryers  
7 on each unit, and the dryer beds are changed  
8 periodically. That's basically a routine operation.

9 Key things like the losses and the make  
10 up and the most important one being the tritium  
11 emissions are tracked.

12 Q. Tritium emissions depend upon the  
13 dryers?

14 A. Correct, yes.

15 Q. But you don't actually have a  
16 formally implemented system which you follow?

17 A. We track our losses, yes. We tract  
18 our losses and if the losses were to increase, you  
19 know, that would be investigated, and we would attempt  
20 to pin down the source of the heavy water.

21 The collection systems on the plant, we  
22 have a collection system that have collects from the  
23 heat transport system, we have a collection system that  
24 collects from the moderator system. So it's usually  
25 fairly apparent from which system the heavy water is

1 leaking and operators/maintainers or will follow up to  
2 investigate -- typically the leakage is from a valve  
3 or --

4 Q. Are you quite certain that you  
5 collect 95 per cent? Is that monitored?

6 THE CHAIRMAN: I think he said they do an  
7 accounting.

8 MR. DALY: Yes, the collection rate is  
9 monitored. The collection of heavy water goes into  
10 what we call collection tanks and the amount of that  
11 collection is tracked routinely. So we know how much  
12 water is leaking out the system, and if that changes  
13 significantly then we follow up and find where it's  
14 coming from.

15 MRS. deQUEHEN: Q. I am just asking  
16 because we have a numbers problem, something that  
17 doesn't add up.

18 THE CHAIRMAN: I think we are nearly - in  
19 fact we just passed five o'clock.

20 MRS. deQUEHEN: Could I just ask two more  
21 questions, please?

22 THE CHAIRMAN: As long as they can be  
23 given and answered in five minutes.

24 MRS. deQUEHEN: CFFTP document in tab 3  
25 which is by McElroy and Wong.

1 DR. WHILLANS: Could we have the page  
2 number please. We don't have tabs.

3 MS. PATTERSON: Exhibit 672.

4 DR. WHILLANS: Different document.

5 Sorry.

6 MRS. deQUEHEN: Q. Exhibit 672, tab 3,  
7 McElroy and Wong, these people do a lot of your  
8 monitoring and safety analysis, don't they?

9 DR. WHILLANS: A. Dr. McElroy is the  
10 head of the Health Physics Branch at AECL. The  
11 co-author, Dr. Wong is employed CFFTP. They are both  
12 managers.

13 Q. If you could turn to page 3, the last  
14 paragraph, page 3 of this publication. One curie  
15 equals 37,000 becquerels.

16 A. Yes. It's a typographical error  
17 there, it's a microcurie. I think someone just left  
18 out of the symbol for micro.

19 Q. Oh. Because it's out by 10 to the  
20 6th and this--

21 A. That's right.

22 Q. --and this publication is published,  
23 floating around the library.

24 A. Yes, I accept that.

25 Q. I wonder whether that could account

1 for a problem we have had.

2 Just one more question. The  
3 cost-effectiveness reduction of off-site dose by  
4 Atlantic Nuclear Services, why did they not take vapour  
5 control methods, cost effectiveness of vapour control  
6 into account? It seems to me the whole of the  
7 emissions really depends upon their process of --  
8 tritium emissions, I am talking about. Why was it left  
9 out, Mr. Daly?

10 MR. DALY: A. Are you referring to the  
11 study that was discussed earlier with Mr. Johansen that  
12 focussed on liquid waste?

13 Q. No. I am wondering why if you were  
14 really looking at cost-effectiveness of reduction of  
15 off-site dose, why they did not assess the vapour  
16 collection system?

17 MR. PENN: A. Well, I think it's because  
18 the system we have designed is highly successful, and  
19 the room for improvement is very small.

20 If I am understanding your question  
21 properly, when we first designed CANDU reactors at  
22 Pickering, we had concerns about loss of heavy water  
23 and its recovery. And that's one of the systems that  
24 proved to be highly efficient, and there isn't room for  
25 much further improvement.

1 MRS. deQUEHEN: Thank you.

2 THE CHAIRMAN: Thank you very much. Mrs.  
3 Young.

4 MS. PATTERSON: Just while you are  
5 setting up, I was wondering whether, Mrs. deQuehen,  
6 you would like reference 53 to be separately entered as  
7 individual interrogatories. Did you want these  
8 interrogatories as exhibits?

9 MRS. deQUEHEN: I don't know.

10 THE CHAIRMAN: Why don't we put that in  
11 as one interrogatory package.

12 MS. PATTERSON: But you want us to use  
13 it?

14 MRS. deQUEHEN: It's not necessary.

15 ---Off the record discussion.

16 MS. PATTERSON: The next interrogatory  
17 number?

18 THE REGISTRAR: .174.

19 MS. PATTERSON: Would be the package that  
20 starts with interrogatory 9.22.72.

21 THE REGISTRAR: 9.22.72. Thank you.

22 ---EXHIBIT NO. 520.174: Interrogatory No. 9.22.72.

23 THE CHAIRMAN: Just a moment. I think we  
24 should give, there was a document that was with Exhibit  
25 679 which is the document entitled Canadian Tritium

1       Experience. It probably should be given a separate  
2       exhibit number. Can we mark that as a separate  
3       exhibit.

4                             THE REGISTRAR: This piece here, Mr.  
5       Chairman.

6                             THE CHAIRMAN: It has got Contents  
7       printed on the top, Canadian Tritium Experience.

8                             THE REGISTRAR: That then will be a  
9       separate number. 680.

10                          THE CHAIRMAN: Because it was with Panel  
11       3, but I think it is a separate document.

12                          MRS. deQUEHEN: Thank you.

13                          THE REGISTRAR: Yes, No. 680.

14       ---EXHIBIT NO. 680: Document entitled Canadian Tritium  
15       Experience.

16                          THE CHAIRMAN: Thank you.

17                          MRS. YOUNG: I don't think, Mr. Chairman,  
18       I have given copies of the material I intend to refer  
19       to Mr. Lucas and to the members of the Hydro's panel.  
20       I wonder if it is necessary to give it a number.

21                          THE CHAIRMAN: Well, I will look at it  
22       for a moment and see what it is.

23                          Perhaps the best thing to do would be to  
24       give the package a number.

25                          What would that be, Mr. Lucas?

1                   THE REGISTRAR: That will be 681.

2                   THE CHAIRMAN: Thank you.

3                   ---EXHIBIT NO. 681: Cross-Examination material, Mrs.  
4                   Young.

5                   MRS. YOUNG: Thank you.

6                   My name is Joanne Young and I am an  
7                   independent intervenor in these Demand/Supply Plan  
8                   hearings.

9                   Today my concerns in cross-examining the  
10                  panel on nuclear options is with the protection of the  
11                  health and safety of workers in the nuclear industry,  
12                  especially of workers in the mining, milling and  
13                  refining of the uranium fuel used in Ontario Hydro's  
14                  nuclear reactors.

15                  I believe Dr. Whillans is the person to  
16                  whom I should address my questions. However, if other  
17                  panel members wish to comment or contribute in any way,  
18                  I hope they will feel free to do so.

19                  CROSS-EXAMINATION BY MRS. YOUNG:

20                  Q. To begin then, would you agree, Dr.  
21                  Whillans, that employers have a responsibility to  
22                  protect the health of their workers?

23                  DR. WHILLANS: A. I agree.

24                  Q. Turning to the first item in the  
25                  information provided, a study entitled Bronchogenic

1       Carcinoma Among Former Uranium Mine Workers at Port  
2       Radium in Canada. The study covers the years from 1942  
3       to 1960 and was published in 1979, 37 years after the  
4       miners began working in the uranium mines in Port  
5       Radium. This mine is owned by Eldorado, now known as  
6       Cameco.

7       [5:10 p.m.]

8                   Of 73 miners who had five or more  
9                   years of work underground, 10 were found  
10                  to have registered as lung cancer cases  
11                  in Alberta by the time the study was  
12                  published.

13                  The figure of 10 as a matter of fact may  
14                  be a bit low as authors of the study point out on page  
15                  004, okay, on the second column near the bottom:

16                  Underground workers may be less  
17                  likely to settle in Alberta due to the  
18                  relative lack of similar occupational  
19                  opportunities. Therefore, perhaps some  
20                  of these miners had left Alberta for work  
21                  elsewhere and, therefore, would not show  
22                  up as cancer cases in Alberta.

23                  On page 005 of the same study the authors  
24                  state that they:

25                  Plan to inform the miners of the

1                   desirability of seeking medical  
2                   surveillance and identifying survivors of  
3                   the deceased so that they may be informed  
4                   of their potential compensation rights.

5                   Would you agree then that it was the  
6                   impression of the authors of the study that these men  
7                   may have been unaware of the cause of their cancers and  
8                   also probably unaware of their rights to compensation?

9                   A. Well, Mrs. Young, you asked a number  
10                  of interrogatories to do with mine workers and others  
11                  that are not Hydro employees and we answered generally  
12                  that we often just don't have the information.

13                  We are aware of studies like this. I'm  
14                  certainly aware that many miners have developed  
15                  carcinomas and this has been related to their exposure  
16                  to radiation, but I'm not aware of any of the details  
17                  of how these companies control their exposures or  
18                  operate them or how they operate their compensation  
19                  systems. I'm afraid I can't help you very much.

20                  Q. I'm concerned really with the  
21                  impression the authors seem to convey here that the  
22                  miners themselves were unaware.

23                  A. Well, perhaps I missed it when you  
24                  were pointing that section out. I have a problem  
25                  that's it's very difficult to read my copy, and so I

1 haven't looked at it through --

2 Q. I'm sorry, it is an old copy, it's  
3 been xeroxed many times.

4 A. Yes.

5 Q. This is at the bottom of the first  
6 column on page 005.

7 THE CHAIRMAN: The numbers appear at the  
8 top right-hand corner.

9 MRS. YOUNG: Yes. I'm sorry, they are  
10 quite small.

11 DR. WHILLANS: Yes, I have it. The last  
12 paragraph?

13 MRS. YOUNG: Q. Yes.

14 DR. WHILLANS: A. Yes, I agree with you,  
15 that would be the purpose of tracing them, I suppose.

16 Q. Right. I was myself unable to  
17 determine whether any had received compensation since  
18 this information is not available from the Alberta  
19 Compensation Board on the ground of confidentiality.

20 On page 003 of the same study it is  
21 stated that:

22 The patient index system..., and I'm  
23 sorry, this is near the bottom of the first column:

24 The matching process was based on  
25 name, sex and, when available, on date of

1                   birth. Each employee record was compared  
2                   with the patient index system listings of  
3                   patients whose names were similar in  
4                   spelling or pronunciation.

5                   This way of tracing the names suggested  
6                   to me that possibly some of these miners may have been  
7                   illiterate.

8                   I wonder if you could agree with me on  
9                   that, the significance of the fact that some of them  
10                  apparently were unable to spell their names correctly?

11                  A. Well, that's a possibility, but I'm  
12                  aware that in many record systems basically errors made  
13                  in entering the name even though the name was given to  
14                  them properly occur.

15                  Q. Yes.

16                  A. And this kind of exercise is carried  
17                  out for many record systems. So it may be what you  
18                  suggest, but it could be something else as well.

19                  Q. Yes, it could. Thank you, Dr.  
20                  Whillans.

21                  Would you agree that this study indicates  
22                  a high rate of cancer among miners in Eldorado's Port  
23                  Radium Mine who were employed for underground for five  
24                  years or more in the 1940s and the 1950s?

25                  A. Well, again, I'm not an expert in

1       this area but it certainly seems to, yes.

2                   Q. Yes. Would you agree that many may  
3       not have been compensated?

4                   A. I'm sorry, I don't know.

5                   Q. Right. Would you agree that in that  
6       case, the cause of the illness and death and the  
7       support of their dependent families was likely to fall  
8       on the general taxpayer if they were not compensated?

9                   A. It would seem reasonable.

10                  Q. Yes, thank you. In an industry such  
11       as the nuclear industry where workers' health may be  
12       severely damaged even to the extent where it may result  
13       in death without his or her being aware of it at the  
14       time the damage occurs, would you agree that employers  
15       have a very heavy responsibility to take extra care to  
16       monitor employees and to inform them of the health  
17       risks?

18                  A. Yes, I agree.

19                  Q. And would you agree that such an  
20       employer also has an obligation to ensure that their  
21       workers are properly compensated when damage to their  
22       health results from working conditions?

23                  A. I think that is fair.

24                  Q. Thank you, Dr. Whillans.

25                  The next items are two packages of

1 quotations from the authorized history of Eldorado by  
2 Robert Bothwell. This is going to be picking spots  
3 here and there. As we all know Eldorado owned the Port  
4 Radium Mine as well as all of, I believe, all of  
5 Canada's refineries over the last 50 years or so.

6 I'm going to begin at the last paragraph  
7 on page 104:

8                   The mine was geared to maximum  
9                   production. The Americans wanted as much  
10                  uranium as possible, as fast as possible.

11                  Then to the last paragraph on page 105,  
12 just beginning a few lines above that:

13                  But if conditions above ground were  
14                  better, those below ground were in many  
15                  respects worse.

16                  This relates to the opening of Port  
17 Radium Mine in 1942 after it had been flooded for a  
18 couple of years.

19                  The basic cause was the tendency of  
20                  Great Bear Lake to flood the mine.

21                  Frozen chunks of ore, which in 1940 had  
22                  been abandoned when the mine was closed,  
23                  broken were found when the mine was  
24                  reopened. The temperature of the rock  
25                  was 19 degrees fahrenheit..., which of

1 course is below freezing.

2 To move it it must be thawed. To  
3 thaw it, electric heaters were brought in  
4 and ventilation reduced. Reducing  
5 ventilation was a problem because,  
6 unknown to the mine management it  
7 encouraged the development of pockets of  
8 radon gas. While it should be underlined  
9 that the state of knowledge of the day  
10 permitted such a technique, the  
11 longer-term consequences of exposing the  
12 miners to radioactivity were bound to be  
13 unfortunate. It was a mean place to work  
14 in those days, Dick Murphy sighed.

15 I believe he was one of the geologists:

16 But given the rush to get back into  
17 production before the effects of the  
18 flooding and freezing could be dealt  
19 with, there was little that could be done  
20 about it.

21 These paragraphs then describe working  
22 conditions at the Port Radium Mine when it was reopened  
23 in 1942 to supply uranium for the Americans for  
24 development of the atomic bomb.

25 Would you agree that management was aware

1       of the dangers of radiation but felt helpless to deal  
2       with it?

3                     MS. HARVIE: Mr. Chairman, perhaps I will  
4       just rise at this point and point out to you and to  
5       Mrs. Young that I don't -- unless Dr. Whillans has  
6       particular knowledge of management's intentions at the  
7       time, I don't think he would be able to give evidence  
8       on that point.

9                     MRS. YOUNG: But is it not clear from the  
10      quotation from what Dr. Murphy had to say, or I'm  
11      sorry, Dick Murphy:

12                  Given the rush to get back into  
13                  production before the effects of the  
14                  flooding and freezing could be dealt  
15                  with, there was little that could be done  
16                  about it.

17                  It appears that they were aware of the  
18      dangers.

19                  THE CHAIRMAN: I'm not worrying that that  
20      is not a correct and accurate statement, it's just that  
21      maybe Dr. Whillans doesn't know whether it's right or  
22      wrong because he doesn't know anything about it.

23                  I don't know whether he does or not, but  
24      this was in the war time and all those conditions that  
25      involved then --

1 DR. WHILLANS: Well, I can't really say  
2 anything other than agree that this is what it says.

3 MRS. YOUNG: Q. Yes.

4 DR. WHILLANS: A. I don't know the  
5 conditions.

6 Q. Of course it is an authorized  
7 biography. I believe Robert Bothwell obtained his  
8 information from papers that were supplied by Eldorado.

9 Going on, on page 204 and 205 at the very  
10 bottom under the 2 there, 2 in Roman numerals:

11 To top it off, the mine was now  
12 asserted to be unsafe. It was not unsafe  
13 for any of the familiar reasons. The  
14 pumps kept the lake out of the mine,  
15 repairs shored up the consequences of  
16 water damage and heaters kept the miners  
17 from freezing at least in the upper  
18 levels of the shaft. Unfortunately the  
19 company was faced with the safety problem  
20 of a different kind, radioactive ores  
21 exposed to the air produce radon gas,  
22 radon gas gives off alpha particles and  
23 alpha particles can lead to an exposure  
24 to radiation.  
25 We are at the top of page 205 now.

1                   Radon gas could not, in ordinary  
2                   circumstances, have posed a threat but  
3                   two conditions at the mine contributed to  
4                   its incidence. First, the mine was not  
5                   particularly well ventilated and,  
6                   secondly, its ventilation ducts were  
7                   sometimes stopped up to keep cold air out  
8                   and warm air heated by the portable  
9                   electric devices in. The Port Radium  
10                  Mine...,

11                  We are at the middle of the next  
12                  paragraph now:

13                  The Port Radium Mine had a very high  
14                  concentration of radon gas according to  
15                  F.A. Paneth of the Montreal labs.  
16                  The radon content seems to be so high as  
17                  to be definitely dangerous to the health  
18                  of those working in the mines. It was in  
19                  his words a very serious industrial  
20                  hazard for which ample precedence  
21                  existed. The most notable of these was  
22                  the St. Joaquim Falls Mine whose radon  
23                  concentrations equalled those found at  
24                  Eldorado and where it was known that  
25                  about 50 per cent of the miners have

1                   eventually been dying of lung diseases.  
2                   This is according to F.A. Paneth since  
3                   it's all in quotes there.

4                   Then going on:

5                   It was not news to scientists  
6                   working with radiation but it was news to  
7                   mining engineers used to working in  
8                   ordinary mines.

9                   This then describes in more detail the  
10                  problems with radioactivity in the mine.

11                  On page 207 then, possible symptoms of  
12                  lung cancer are described by someone known as Leslie  
13                  Thomson and in other locations in the book Mr. Thomson  
14                  is described as a middle-aged Montrealer, Secretary of  
15                  the Department of Munitions and Supply during the war.

16                  On page 206 then near the bottom of that  
17                  first paragraph:

18                  Thomson noted a peculiar cough. It  
19                  could well be, as the mine doctor argued,  
20                  that it was just low temperature and high  
21                  moisture. This was a reasonable  
22                  conclusion under the circumstances.

23                  Though worried Thomson took comfort in  
24                  taking advice and the advice he had was  
25                  that fans, motors and the like, et

1                   cetera, would ventilate the mine and  
2                   clear the hazard.

3                   Once again then it appears that possible  
4                   symptoms of lung cancer among the miners were described  
5                   by Mr. Thomson.

6                   Would you agree again that in 1946  
7                   management was still well aware of the dangers but  
8                   judging from this study that we checked out earlier by  
9                   Grace, Larson and Hanson they failed to take adequate  
10                  action to ensure the health and safety of the workers?

11                  DR. WHILLANS: A. Well, I'm afraid all I  
12                  can comment is that these conditions that are described  
13                  are certainly those that would be unacceptable today.

14                  I am not sure that it was well-known to  
15                  scientists in 1942 the extent of the hazard for the  
16                  production of lung cancer from radon exposure.

17                  I'm not an expert in this area and there  
18                  are certainly many scientific accounts of the  
19                  development of this knowledge. But I think I said in  
20                  direct evidence, even in 1960 the importance of the  
21                  induction of cancer from radiation generally not just  
22                  from radon was just beginning to be understood.

23                  Q. Yes.

24                  A. I think at this time, in '42, it  
25                  would be doubtful whether it would be a general

1 consensus that this was an important problem, but I'm  
2 not an expert in that area.

3 Q. Yes. Thank you, Dr. Whillans. I  
4 have been able to obtain only one file from the  
5 Workers' Compensation Board on a worker who was  
6 employed at Eldorado's Uranium Refinery in Port Hope  
7 who died of cancer.

8 The next two packages refer to examples  
9 from this case. On the third page of the fourth  
10 package there is a summary of exposure findings for a  
11 worker at Eldorado's Port Hope Uranium Refinery showing  
12 weekly exposure, cumulative exposure, and permissible  
13 tolerance cumulative, presumably to beta gamma.

14 A. I'm sorry, which package is this?

15 Q. Oh, I'm sorry, this is the one next  
16 in the row. It starts with Building No. 12 at  
17 Eldorado. Eldorado Mining and Refining, Port Hope  
18 Refinery.

19 A. The one with the title Eldorado  
20 Mining and Refining, Port Hope Refinery?

21 Q. Yes, and it's headed Incident. I'm  
22 sorry, it starts with Building No. 12. It's headed  
23 Incident. Yes.

24 A. Yes. And the table is on the third  
25 page?

1                   Q. Four pages into this, I'm sorry.

2                   A. Yes, okay. Summary of exposure  
3                   findings.

4                   Q. Yes. Would you agree that if maximum  
5                   permissible tolerance, as it says just here, was 6.5  
6                   rem per quarter, that this company must have been  
7                   working to a 26 rem year?

8                   A. Yes, I believe the 'r' is roentgen at  
9                   that time. Generally it's the same thing, so it looks  
10                  like you are right.

11                  Q. Yes. Are you aware that similar  
12                  industries at the time, for example, in the United  
13                  Kingdom were working to a 5 rem year with an  
14                  engineering safety factor of 3, effectively then  
15                  working to a 1 to 2 rem year?

16                  A. Well, I'm not really aware of what  
17                  happened in the U.K. but the ICRP's recommendation on  
18                  annual dose limit, for example, was reduced from 15 to  
19                  5 rem I think in the mid-50s.

20                  [5:26 p.m.]

21                  Q. Yes. I understand Eldorado was one  
22                  of the last people to implement that's recommendations  
23                  from ICRP.

24                  A. I don't know.

25                  Q. You will note that readings are given

1 to hundreds of one rem. Would you agree that this  
2 gives an impression of considerable accuracy in the  
3 readings?

4 A. Yes, I agree.

5 Q. On the next page we find a letter  
6 from Dr. Ashmore, head of the National Dose Registry of  
7 the Occupational Radiation Hazards Division of Health &  
8 Welfare Canada. After describing the badges and  
9 possible means of interpreting them, Dr. Ashmore refers  
10 to the fact that this very large uncertainty, this is  
11 just at almost the end of the third paragraph, almost  
12 the end of the page.

13 This very large uncertainty in the  
14 reading reflects the difficulty in trying  
15 to determine the dose received by an  
16 individual.

17 Would you agree, then, that almost 40  
18 years ago, in 1952-3 a dosimeter badge was likely to  
19 have been less accurate than those described by Dr.  
20 Ashmore in 1990?

21 A. It sounds likely, yes.

22 Q. Yes. Do you believe it is possible  
23 that officials at Eldorado, in forwarding these  
24 readings to the Workers' Compensation Board, may been  
25 pretending to an accuracy which they knew did not

1 exist?

2                   A. Well, I agree it gives that  
3 impression. But I have to admit that Ontario Hydro's  
4 records are kept to three figures when I think we are  
5 all quite aware that the accuracy isn't all that great.  
6 The objective is to make sure that rounding and so  
7 forth doesn't add to the error. But I think the  
8 impression that you get as a lay person reading the  
9 table is probably not what was intended.

10                  Q. Right. Thank you, Dr. Whillans. You  
11 will have noticed, I think, that just above what I just  
12 quoted, the ICRP recommends today dosimeters should be  
13 able to measure whole body dose to within plus 50 per  
14 cent.

15                  A. I think that should have been plus or  
16 minus, actually. These refer to the external TLD  
17 dosimeters that people use to measure external  
18 radiation.

19                  Q. It doesn't strike me as being  
20 accurate to one hundredth of a rem.

21                  A. That's right.

22                  Q. Right. We go on, then, from there to  
23 a report from Mr. Stan Frost on the next page, health  
24 physicist for Eldorado Cameco, who claims in 1988 --

25                  A. Sorry. I don't see Mr. Frost's name.

1                   Q. It's addressed to Dr. C. Stewart.

2       And halfway down the first page is a Film Badge  
3       Records.

4                   A. Yes.

5                   Q. Over the next page --

6                   A. I think perhaps I don't have the last  
7       page.

8                   Q. Oh, is it on the back of the first  
9       page?

10                  A. I have two pages, but it continues at  
11       the end, "using the dose..."

12                  Q. Yes. I did cut it off there because  
13       I was concerned mostly with the film badge record.  
14       About half, maybe two thirds of the way down, this  
15       first paragraph:

16                  The operators of the badge program  
17       recognized that they were overestimating  
18       and periodically read the filtered  
19       portion of films exhibiting higher  
20       exposures to get an accurate assessment  
21       of gamma dose.

22                  But he does say earlier that as a matter  
23       of routine, the badges were read through the unfiltered  
24       portions, giving an estimate of exposure which Mr.  
25       Frost believes was about four times the actual

1 exposure.

2                   A. I really can't comment. We don't use  
3 the same service as Eldorado or Cameco. And, you know,  
4 this is sort of a technical argument that I really  
5 don't have any knowledge of.

6                   Q. Right. I wanted to point out that  
7 while the badge records were apparently inaccurate to  
8 begin with, Mr. Frost felt in 1988 that it was time to  
9 correct this matter. And the actual dose received,  
10 according to Mr. Frost, was one-third of that  
11 registered.

12                  Would you agree, though, that this is  
13 difficult to determine when Mr. Frost has not been able  
14 to produce either the badges or the badge records?

15                  A. Well, it certainly would be  
16 difficult. I would think that the matter of changing  
17 an official dose would be a subject that the AECB would  
18 have to approve and they should be interested in  
19 whether or not it's justified.

20                  Q. Apparently they have no records of  
21 this period of time. I called Mr. Frost and asked him  
22 if he could send me these, at least the badge records,  
23 which, even if the badges had been disposed of I would  
24 have expected that the records would have been on  
25 microfilm. He denied having lost them and told me that

1       they would be in my possession as soon as he could find  
2       them. That must have been three years ago, and I  
3       haven't heard from him.

4                     A. Well, that sounds like there should  
5       have been some communication. These were a very long  
6       time ago, and it is possible that he couldn't find them  
7       but he should have, I guess, told you so.

8                     Q. Would you agree, though, that since  
9       Mr. Frost states the operators of the badge program  
10      recognized that they were overestimating and  
11      periodically read the filtered portion of films  
12      exhibiting higher exposures to get an accurate estimate  
13      of gamma dose that these badges would have been read  
14      with extreme care by this company to ensure that there  
15      was no chance of any overestimate before the results  
16      were released, particularly to the Workers'  
17      Compensation Board, which was investigating the death  
18      of one of their workers.

19                     A. I really can't comment. It sounds  
20      optimistic.

21                     Q. I won't ask you if you would agree  
22      with me that Mr. Frost's revised estimates are  
23      unreliable.

24                     At the first page of this package, there  
25      is a letter signed by Eldorado safety engineer

1       describing an incident involving ingestion and  
2       inhalation of alpha particles. Please note the last  
3       paragraph on this page. It is the writer's  
4       recollection that alpha surveys made shortly after the  
5       incident indicated much less contamination than was at  
6       first thought. Would you agree that this statement is  
7       unacceptable as the only report received on exposure to  
8       alpha particles from a Crown-owned uranium refinery on  
9       an incident which may have cost the life of a young  
10      engineer?

11                  A. I really can't comment. It would  
12       only be a personal opinion.

13                  Q. Yes, yes. It seems to me to exhibit  
14       a rather carefree attitude. He has not told us how the  
15       alpha particles were measured, when they were measured,  
16       what the measurements were, what the expected  
17       measurements were. In the same paragraph at the end,  
18       he says, samples of urine were taken and sent to Chalk  
19       River and found negative.

20                  Now, the results of that test are on page  
21       3 here, and I have very little scientific training but  
22       this one has me buffaloed. Three alpha disintegrations  
23       per minute in a 650 millilitre sample. You know, you  
24       have got your real number line, right, and you have got  
25       the positive numbers at one end and the negative at the

1 other. And I can't see how these numbers can be  
2 described as negative.

3 [5:35 p.m.]

4 A. Sorry, where is the word "negative"?

5 Q. At the very bottom of this.

6 A. In the letter.

7 THE CHAIRMAN: In the letter is a  
8 description as negative and in the analysis.

9 MRS. YOUNG: No, not in the analysis, but  
10 in the letter to the Workers' Compensation Board from  
11 Eldorado safety engineer, they are described as  
12 negative.

13 DR. WHILLANS: I guess all I, and this  
14 isn't very useful, all I can comment is that I notice  
15 at the top of the page that a copy was sent to Dr.  
16 Muller, and I assuming it's Dr. Yon Muller who has a  
17 very high reputation I think for his work with miners  
18 and their radiation problems, and I would have expected  
19 that he would have commented on it. But I really --

20 MRS. YOUNG: Q. I would have expected  
21 that myself, Dr. Whillans, but he hasn't.

22 MR. PENN: A. I don't know if this is  
23 helpful, but I don't know Dr. Muller directly, but I  
24 believe he is retired now. He has a very sick wife.

25 Q. Has he.

1                   A. Yes.

2                   Q. I'm sorry to hear that. I have never  
3                   met Dr. Muller but he has been called as a consultant  
4                   on this case, not only in 1979 but at the time of the  
5                   appeal in 1988.

6                   A. Well, I do know that his wife has  
7                   Alzheimers disease and for create quite a number of  
8                   years.

9                   Q. I'm sorry to hear that.

10                  DR. WHILLANS: A. Actually, he has been  
11                  quite ill himself.

12                  Q. Alzheimers can be a devastating  
13                  illness, in fact it almost always is a devastating  
14                  illness.

15                  The last page of the package then  
16                  contains a quote from the book Blind Faith by Penny  
17                  Sammer.

18                  THE CHAIRMAN: Is that page 147?

19                  MRS. YOUNG: Yes.

20                  THE CHAIRMAN: It follows right after the  
21                  matter addressed to Dr. Stewart.

22                  MRS. YOUNG: Right.

23                  Q. The last half of the first paragraph  
24                  there, at the very top. This was another victim of  
25                  cancer who worked at Eldorado.

1                   How Ron Hills' exposure level was  
2                   determined was never made clear publicly.  
3                   Paul Falkowski who had the right to  
4                   search Hills' WCB file - and he was the  
5                   lawyer for Hills - said he meet with  
6                   obstruction and empty files and for a  
7                   long time he never saw the supporting  
8                   material. When he finally did, some of  
9                   the flimsily identified readings taken of  
10                  radioactivity in the plant during the  
11                  years 1952 to 1956 showed concentrations  
12                  of up to 1,600 picacuries per litre.  
13                  ...of air in that plant.

14                  Would you agree, Dr. Whillans, that this  
15                  is an extremely high level of radioactivity for air in  
16                  a plant, and certainly the lawyer who was representing  
17                  a worker who had contracted cancer should have been  
18                  informed at once.

19                  THE CHAIRMAN: First of all, let's find  
20                  out if they consider it a high amount.

21                  DR. WHILLANS: Well, the action level  
22                  for remedial activity for radon in homes is I think  
23                  about 4 -- sorry, the normal level? It's the order of  
24                  4 or 20 in Canada picacuries per litre. But very much  
25                  lower than this. This is a high activity level, even

1 for a mine.

2 MRS. YOUNG: Q. Yes. At time in the 50s  
3 they were still using some of the buildings that had  
4 been used in the early 30s when radium was the...

5 There has as yet been no comprehensive  
6 epidemiological study of the people of Port Hope.  
7 Since such a study would require about 30 years to  
8 complete, it appears important that it be begin as soon  
9 as possible.

10 It is possible that if the secrecy that  
11 appears to characterize that some of Eldorado's  
12 operations were overcome, perhaps the health of the  
13 workers and of the people in the local community might  
14 be improved considerably. That again is a personal  
15 opinion and I won't ask you if you would agree with me,  
16 Dr. Whillans.

17 DR. WHILLANS: A: As you know, there  
18 have been studies in Ontario. I am not aware of what  
19 the situation is in other provinces, but there have  
20 been -- the detailed series of studies that Dr. Muller  
21 carried out of Ontario miners has been published.

22 Q. Yes, that was brought in as evidence  
23 by Professor Andrews at the appeal but it was ignored  
24 by the company itself, because - as far as I know,  
25 because it may have been favourable to the claimant. I

1 think his study indicated that if you had been exposed  
2 for example to gold mining and then to uranium mining,  
3 that the likelihood of developing cancer was many times  
4 greater than if you had been exposed to the same amount  
5 of time at same levels in just one or the other.

6 A. I'm sorry, I don't know that study  
7 very well.

8 Q. Right. Thank you.

9 The next package constitutes the report  
10 of a representative of the Workers' Compensation Board  
11 who was apparently appointed to investigate this case.  
12 This is here it, Memo No. 1.

13 Would you agree that this  
14 representative's remark at the top of the first page,  
15 Mr. Thomson who was the safety engineer explained to me  
16 that there are three types of radiation.

17 Would you be of the opinion that this  
18 indicates a possible lack of the qualifications  
19 necessary to adequately investigate the death by cancer  
20 of a nuclear worker?

21 Apparently this individual wasn't aware  
22 that we have alpha, beta and gamma.

23 A. Well, he does say that there were  
24 three types, alpha, beta and gamma.

25 Q. Yes. He explains that Mr. Thomson

1       the safety engineer explained this to him. Apparently  
2       he didn't know that until it was explained to him.

3                  A. I don't know whether he didn't know  
4       or was just recording it here. I don't know.

5                  Q. Possibly, yes, he was. Possibly he  
6       was just recording it.

7                  He goes on to explain that the alpha  
8       particles are easily suppressed. They can be shielded  
9       by anything as thin as paper. They travel a very short  
10      distance and there is little or no danger from these  
11      substances at distances greater than one inch from the  
12      source.

13                 Once again, I don't know what was told to  
14      him by the safety engineer and the plant physician and  
15      how much of this he may have known himself, but it  
16      seems significant that he hasn't bothered to point out  
17      that if alpha particles are ingested they are perhaps a  
18      measure of 10 times more dangerous than gamma  
19      radiation?

20                 A. Well, the quality factors we are  
21      talking about with Mrs. deQuehen for alpha particles  
22      are 20.

23                 Q. Twenty.

24                 A. Actually, it's more an inhalation  
25      problem. Ingestion is not such a serious problem

1 because these things tend to be very insoluble and just  
2 pass through the body.

3 Q. Yes. I understood there was some  
4 sort of positive charge and they adhered to the tissue  
5 in the lungs.

6 A. During inhalation, that's right.

7 Q. I am a little concerned that  
8 apparently the Workers' Compensation Board didn't get  
9 much information from the representative who was asked  
10 to investigate this case. I have since asked the  
11 Workers' Compensation Board if it wouldn't be possible  
12 to upgrade the qualifications of some of their  
13 representatives and they pointed out that this would be  
14 a major expense.

15 The last package contains only  
16 interrogatory responses, and these are among those that  
17 you mentioned earlier, Dr. Whillans, that were the  
18 results of some of my interrogatories.

19 The information given, I intend to use  
20 only to a very slight degree.

21 Would it be necessary to give numbers to  
22 the interrogatories, Mr. Lucas?

23 THE CHAIRMAN: We have done it with  
24 everyone else, we should probably be consistent.

25 Are you going to use the three that you

1 have at the end? There is five of them.

2 Do you intend refer to all five?

3 MRS. YOUNG: Really I think only to the  
4 middle three.

5 THE CHAIRMAN: 9.45.30.

6 THE REGISTRAR: That will be .175.

7 THE CHAIRMAN: 9.45.31.

8 THE REGISTRAR: That will be .176.

9 THE CHAIRMAN: And 9.45.32.

10 THE REGISTRAR: .177.

11 ---EXHIBIT NO. 520.175: Interrogatory No. 9.45.30.

12 ---EXHIBIT NO. 520.176: Interrogatory No. 9.45.31.

13 ---EXHIBIT NO. 520.177: Interrogatory No. 9.45.32.

14 MRS. YOUNG: Thank you.

15 Q. Responses to Interrogatory 9.45.30,  
16 and to 9.45.31 indicate that Ontario Hydro does not  
17 rely on the Employer's Adviser from the Compensation  
18 Board when contesting a claim for compensation, and  
19 that the cost to Ontario Hydro, while they vary, may at  
20 times be expensive.

21 Would you agree that such legal costs  
22 would be very difficult for an ill or injured worker to  
23 pay?

24 DR. WHILLANS: A. It's really an area I  
25 am not familiar with. I don't know whether Legal Aid

1       or something like that is available for people in the  
2       situation.

3                     THE CHAIRMAN: These interrogatories  
4       appear to be not responsive to the cost of the claimant  
5       but to the cost to the corporation. Am I reading it  
6       correctly?

7                     MS. PATTERSON: You are just talking  
8       about the cost if the claimant were to have the same  
9       expenses as Hydro.

10                  MRS. YOUNG: Yes, or similar expenses.

11                  Since I have been an intervenor at the  
12      hearings here I have come to understand that you might,  
13      if you are lucky, hire a fairly good lawyer for \$80 an  
14      hour, I think that puts it out of the budget of most  
15      ill or injured workers.

16                  Getting on then to the possibility that  
17      Legal Aid would be available, the Workers' Compensation  
18      Board makes Workers' Advisers available.

19                  I understand that these advisers are  
20      responsible for as much as 3 to 600 cases at a time.

21                  THE CHAIRMAN: Well now, we are getting a  
22      little bit out of, I am sure, anybody's expertise about  
23      how the Workers' Compensation Board operates. It may  
24      not operate very well, but I don't think these  
25      witnesses can help you with that.

1                   MRS. YOUNG: Yes, Mr. Chairman. I merely  
2 wish to point out that this is not a fair situation for  
3 the workers, that they have a very difficult time  
4 coping with this because at times they must wait for  
5 some time simply to obtain the services of a Workers'  
6 Adviser.

7                   The rest of my questions do relate to the  
8 Workers' Compensation Board legislation and the way in  
9 which it might possibly prejudice the claim.

10                  THE CHAIRMAN: I am not sure how that is  
11 going to help us very much in the issues that we have  
12 to deal with.

13                  MRS. YOUNG: I will make my point very  
14 quickly then at the end, Mr. Chairman.

15                  What I am trying to point out here is the  
16 fact that one reason why few workers' deaths are  
17 related to radiation is that some of these workers are  
18 illiterate, some of them are unaware of the hazards and  
19 don't apply for compensation, they simply accept that  
20 cancer happens to anyone, they can't afford to hire a  
21 lawyer, some of them are dead before they can obtain  
22 the services of a Workers' Adviser, and there is no  
23 obligation on the part of the employer to appear at a  
24 board hearing. So it is extremely difficult, as you  
25 may have noticed from some of these submissions, to

1 obtain any sworn testimony from the employer.

2 There is no limit on the amount of time  
3 that he may take to send unsworn possibly irrelevant  
4 submissions to the Board.

5 When this case was appealed it took the  
6 board almost four years to give a decision and the  
7 decision of course was negative. It was appealed in  
8 February of '88, we received our decision in November  
9 of 1991.

10 What I am trying to point out then is  
11 that the reason the nuclear industry is able to claim a  
12 much smaller mortality rate than might actually be the  
13 case, is because the workers are prevented from  
14 presenting their cases and obtaining a fair hearing,  
15 they are of course prevented from going to the courts,  
16 you cannot take that a Workers' Compensation Board to  
17 Court, it must go to the Board, and if the Board  
18 decides against you, you have no appeal.

19 THE CHAIRMAN: I don't know whether  
20 anyone on the panel wants to comment on those remarks,  
21 they don't have to but if they wish to they can.

22 DR. WHILLANS: I guess I can only say  
23 that these responses were prepared by our compensation  
24 benefits group who have specialists who deal with the  
25 Board, and I don't think anyone on the panel does. We

1       really don't know the details of the things that you  
2       are speaking about.

3                   MRS. YOUNG: I could have brought the  
4       entire case, but we wouldn't have got through it in  
5       half an hour.

6       [5:50 p.m.]

7                   THE CHAIRMAN: Well, of course, in  
8       fairness the case didn't involve Ontario Hydro, I  
9       think, if that's right.

10                  MRS. YOUNG: Oh no, it doesn't, it  
11       involves Eldorado. My point is that Eldorado is the  
12       supplier of nuclear fuel to Ontario Hydro's electrical  
13       generating stations and --

14                  THE CHAIRMAN: I understand. I'm not  
15       saying it isn't appropriate, but I just want to make  
16       that point.

17                  MRS. YOUNG: These are all my submissions  
18       then, Mr. Chairman.

19                  THE CHAIRMAN: Thank you, Mrs. Young.

20                  MRS. YOUNG: Thank you very much, and  
21       thank you.

22                  THE CHAIRMAN: Thank you. Ms. Harvie, do  
23       you wish to make any reply?

24                  MS. HARVIE: No, I don't have any  
25       re-direct, Mr. Chairman. I'm sure the witnesses will

1       be relieved to hear that, they are all anxious to  
2       finalize this.

3                     Mr. King did tell me though over the  
4       lunch break that we have over 5,000 pages of transcript  
5       for this panel alone - and I can't believe you  
6       calculated this, Frank - but we have 1,076,000 words  
7       for Panel 9.

8                     One thing I would like to record on the  
9       record though is that there's been a tremendous amount  
10      of effort that has gone into this panel. We've  
11      answered I think in the range of 1,500 interrogatories  
12      and the witnesses have been on the stand for I think  
13      almost eight weeks and we have spent considerable time  
14      preparing.

15                  And although you see the witnesses here  
16      every day, I would like to bring your attention to some  
17      of the other people that have been instrumental in  
18      helping us put together our case, and that is, Mr. Bob  
19      James here who sat up on the front table, and Sophia  
20      Tsakiri-Radke, who I don't believe is here right now,  
21      Pamela Gomes, the woman in the orange, Dr. Geoff Ogram,  
22      who's not here as well but who was sitting on our  
23      panel, the counsel table here for a week, and Mr. Tim  
24      Adamson who is not here as well.

25                  I just wanted to -- oh yes, of course,

1 I'm sorry, and all ably organized by Mr. Glen MacDonald  
2 who sat next to me and advised Mr. Campbell and myself  
3 throughout the cross-examination.

4 Thank you.

5 THE CHAIRMAN: Well, as usual we refrain  
6 from making any comment one way or the other, except I  
7 might personally wish Dr. Whillans a successful and  
8 pleasant trip, wherever he's going.

9 And I guess we'll be adjourning now until  
10 tomorrow morning at ten o'clock.

11 ---Whereupon the hearing was adjourned at 5:55 p.m., to  
12 be reconvened on Thursday, May 14, 1992, at 10:00  
a.m.

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